The Influence of Language Skills on Literacy Acquisition in Arabic/English Bilinguals

by

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Dedication

This thesis is dedicated to the memory of my mother,

Fawzeya Albestawy (1948 - 2003)

A Great Educator

Abstract

Arabic (L1) and English (L2) language and literacy skills in Grade 3 children were examined to determine the predictors of literacy skills in L1 and L2 across Grades 3 and 4. Eighty-two Arabic-speaking children from Kuwait participated in the two-year longitudinal study. Children were followed from Grade 3 (when formal literacy instruction of L2 begins in the state of Kuwait) to the end of Grade 4. A battery of tests was used to measure language and literacy skills in both languages at six-month intervals. This included measures of decoding skills (non-word reading), vocabulary, phonological skills (phonological awareness, rapid automatized naming and phonological memory), orthographic skills (orthographic segmentation, orthographic discrimination and visual memory), morpho-syntactic skills (syntactic awareness and morphological segmentation), and literacy skills (isolated word reading, reading fluency, reading comprehension, comprehension fluency, word spelling, text spelling and writing composition).

Results argued for basic skills to support more complex literacy skills in both reading and writing. For example, the data showed that decoding explained variance in literacy skills in both Arabic and English, and spelling levels were predictive of writing performance in both languages too. Vocabulary, on the other hand, showed less contribution than decoding to literacy in both languages, even when measures of reading comprehension were considered. Phonological awareness influenced literacy mainly via word recognition factors (particularly decoding), whereas rapid naming demonstrated a direct relationship with a number of literacy measures, particularly when fluency was required. While phonological memory was less predictive of literacy than the other measures of phonological skills, it was a significant predictor of non-vowelised Arabic reading comprehension. Although early phonological processing skills were not the predominant predictors of early Arabic literacy, they predicted Arabic literacy in Grade 4, when children begin reading non-vowelised school texts. The data also argued for orthographic skills (which included orthographic discrimination, orthographic segmentation and visual memory) to be better predictors of literacy than phonological skills, particularly for fully vowelised Arabic texts, a finding that may be consistent with views about the complexity of the fully vowelised Arabic script. In addition, measures of morpho-syntactic skills

predicted literacy levels in both languages; and these skills were related to vocabulary suggesting an overlap between the development of vocabulary and the processing of morpho-syntactic features within this cohort of students.

Overall, the findings suggest that a Simple View of Reading and Writing could be applied to Arabic in a similar way to English. However, additional factors related to orthographic segmentation and rapid naming are included as important factors in the Arabic model. Furthermore, the relationships between vocabulary and morpho-syntactic skills are taken into account. Given the need for modifications, a model is proposed that includes these additional factors and which is discussed in light of previous research and theories in the field.

Chapter One: General Introduction

The aim of the present chapter is to give a general introduction to the work and to explain the rationale and questions of the study. It also gives a brief outline of the work conducted.

In Chapter 2, the literacy models, which are used as the base for the current work, and the background to these models, will be discussed in details. The focus, however, will be on the Simple View of Reading as the most important model the present study is based on. It will also discuss other models related to the current work, or provide more explanations to aspects of the literacy that are not quite clear in the Simple View of Reading. Then, it will discuss bilingualism and the context of teaching English (L2) in Kuwait. It will finally discuss the predictors used throughout this work based on the discussion of literacy models and bilingualism.

Chapter 3 will describe the Arabic language (L1) in detail and address some differences between Arabic and English. In addition to that, it will discuss the Kuwaiti dialect briefly, and highlight some issues related to using vernaculars in Arabic, like diglossia. The chapter will also discuss both the models and the research conducted on Arabic. Furthermore, it will describe the context of teaching both Arabic (L1) and English (L2) in the State of Kuwait.

Chapter 4 will then discuss the longitudinal nature of the work and how it was designed. It will also describe the participants of the study and the measures used in the four different times of the study. The measures will be discussed in terms of how they were built, in addition to the pilot work done to construct those measures. It will finally describe the procedures followed.

Chapter 5 will report the results for each of the four assessment points of the study and the concurrent effects of Time 1, Time 2 and Time 3 variables on word reading, decoding, text reading fluency, and word spelling. The results will be shown for each of the study times: Time 1, Time 2 and Time 3. Time 4 results will investigate concurrent effects of the variables in Time 4 on reading comprehension, comprehension fluency, text spelling, and composition coherence.

Chapter 6 will investigate longitudinal predictors of the study's literacy measures. The effects of Time 1, Time 2 and Time 3 variables will be investigated one at a time to see which variables predict Time 4 reading comprehension, comprehension fluency, text spelling, and composition coherence best.

Both Chapter 5 and Chapter 6 will include the descriptive analyses, regression analyses and path analyses conducted to investigate both literacy predictors and trajectories of underlying skills.

Finally, Chapter 7 will discuss both the concurrent and longitudinal results of the study as well as examine the theoretical and practical implications. It will also suggest limitations of the work and future research relevant to the work presented. General models of reading and writing in Arabic (L1) will be suggested based on the results.

Literacy can have a large impact on an individual. It has become a requirement for all forms of education, especially for higher education – and a good education can lead to better job prospects. The most common understanding of literacy is that it is a set of tangible skills – particularly the cognitive skills of reading and writing – that are independent of the context in which they are acquired and the background of the person who acquires them (UNESCO, 2006). Since currently many individuals are bilinguals, UNESCO supports bilingual and/or multilingual education at all levels of education as a means of promoting both social and gender equality and as a key element of linguistically diverse societies (UNESCO, 2003). UNESCO states that "*The actual distribution of linguistic diversity is uneven. Over 70 per cent of all languages in the world are found in just 20 nation states, among them some of the poorest countries in the world. In general, however, bilingual and multilingual contexts, that is, the presence of different linguistic groups living in the same country, are the norm rather than the exception throughout the world, both in the North and the South*" (UNESCO, 2003, p12). In Kuwait, many individuals are Arabic/English bilinguals and the state schools teach both languages in a structured manner. Although the formal language of the country and the basic language of schooling is Arabic, Kuwait also focuses on English as a second language since good performance in English has become an important factor affecting those wishing to pursue higher education. For example, at Kuwait University, English is the official language of many colleges including, but not limited to, medicine, engineering, sciences, business, and administration. Therefore, the teaching of literacy in the child's home language (Arabic) and in English is part of the Kuwaiti government education curriculum. In a survey conducted by Kuwait National Assembly in 2008, reforming education was the first issue chosen by over 50% of the Kuwaiti citizens to be a priority for the new council (Kuwait National Assembly, 2008). A study conducted by Kuwait National Assembly demonstrates the problems of education in Kuwait; one of these problems is the illiteracy rate amongst Kuwaitis which was 3.7% and 5% of the total population of the country including both Kuwaitis and non-Kuwaitis in 2007 according to the study. Literacy in Kuwait refers to the knowledge of reading, writing and numeric literacy (Kuwait Trade Union Federation, 2013).The study also shows that pre-university education was stated to be of low quality in government schools in comparison to private schools in Kuwait. One of the areas noted was the teaching of English literacy skills in which Kuwaiti students have been found to score poorly in international evaluations (e.g., PIRLS: http://www.pirls.org/). The study also indicates that the new curricula applied by the Ministry of Education require a good standard of the Arabic language, despite the level of the language for primary students being weak. For example, some of the concepts that used to be taught in Grade 5 are now in Grade 2 and Grade 3 books, which is quite challenging for the students and delays their academic achievement (Kuwait National Assembly, 2009).

There is a large body of research examining the influence of basic language skills on the literacy acquisition of languages. Many of the studies focus on the acquisition of English as a first or a second language. Generally speaking, the studies on literacy acquisition of other languages, such as Arabic, are not only limited in number, but more importantly, in quality, compared to those conducted on the English language. As a matter of fact, the first edited book of empirical research into language and literacy development in Arabic did not appear until two years ago (Saiegh -Haddad and Joshi, 2014). An area where there has been less attention is the topic of literacy in Arabic as a first language. The intent of this study is to examine the relationship between early literacy skills and later reading in Arabic as a first language (L1) and English as a second language (L2). An additional objective is to determine whether basic literacy skills in Arabic and English develop in parallel.

As far as we are aware, no previous research has used a longitudinal study to investigate the relationship between early language skills and later success in Arabic/English literacy acquisition in the State of Kuwait. The only longitudinal study the researcher could access was a study by Boukadida (2008) on the relationship between phonological and morphological awareness and learning to read in Arabic for preschoolers in Tunisia. The present study seeks to measure if basic Arabic and English language skills influence literacy acquisition of a first/second language respectively. Furthermore, it aims at measuring the degree of this influence (if found) on the literacy acquisition of both languages so that suitable intervention programmes can be used if the individuals show any form of literacy deficit. It also aims at creating a model of Arabic literacy acquisition based on the data collected throughout the different times of the study.

Rationale of the Study

This study investigates literacy for Arabic/English bilinguals on two levels: word level and text level. Based on the Simple View of Reading (Gough and Tunmer, 1986), the study investigates the two sets of important factors that literacy is affected by: the first are the factors related to the nature of the orthography and attributes related to the nature of the target language, and the second are the factors related to the skills of the individual. The study investigates the factors affecting the mechanism of reading/writing at the word-level. These are the phonological skills and orthographic skills needed to decode/encode language input, and the ability of the individual's both visual memory and phonological memory to retain this phonological/visual input until the process of decoding/encoding happens and the child reads/spells the word successfully. On the text (comprehension) level, the study investigates the morpho-syntactic skills and vocabulary that individuals use to fully comprehend the text being read or produce a coherent text. Therefore, the skills that will be investigated throughout the study are decoding, vocabulary, phonological processing, orthographic processing, and morpho-syntactic awareness.

Although there have been numerous studies in the past half-century on predictors of reading in a first language (LI), it is only recently that this research has been extended to second language learning (L2). Even within this area of second language learning, most studies have investigated L2 learners who are trying to learn the primary language of the country to which their families have moved, rather than those opting to learn a second language while still in their LI community, as is the case with Arabic students in mainstream schools in the State of Kuwait, who learn English as a second language. Today's parents and educators continue to need evidence-based information about factors that influence reading proficiency in a second language (e.g., English).

Aims of the Current tudy

First, children in the current study are going to be followed from the beginning of Grade 3 primary through the end of Grade 4, and tested in both Arabic (L1) and English (L2). The aim is to identify processes that underlie literacy acquisition of L1 and L2 in young students in Kuwait and to determine which of these constructs can predict later literacy skills in Arabic and English in Grade 4. Then, concurrent development of basic literacy skills in English and Arabic will be examined to determine the extent to which literacy skills develop in parallel between the two languages. Finally, The applicability of the Simple View of Reading to Arabic is going to be investigated, and a model of Arabic literacy will be created based on the data.

Questions of the Study

1. What are the literacy predictors of Arabic as a first language (L1)?
2. What are the literacy predictors of English as a second language (L2)?
3. Are there any differences between literacy predictors of L1 and L2?
4. Can the Simple View Model of Reading (SVR) apply to Arabic (L1) and English (L2)?
5. Should vocabulary and fluency be added to the SVR in both Arabic and English?
6. Do models of Arabic literacy need to diverge from the SVR when considering vowelised versus non-vowelised text?

Hypotheses of the Study:

1- Phonological and orthographic skills will predict word-level level literacy (i.e. reading and spelling), and decoding, vocabulary, and morpho-syntactic skills will predict text-level literacy (i.e. comprehension and composition) in L1 and L2.

2- Word-level literacy predictors of Arabic (as a shallow orthography) will be different from English (as a deep orthography). Phonological skills will be more predictive of Arabic (due to its phoneme-grapheme consistency) while orthographic skills will be more predictive of English.

3- The SVR can be applied to both L1 and L2.

4- Vocabulary and fluency need to be added to the SVR in L1 and L2.

5- Arabic literacy models will diverge from the basic SVR due to the use of fully vowelised or non-vowelised text.

Chapter Two: Literature Review

Although this study is concerned with investigating literacy for Arabic/English bilinguals whose first language is Arabic and second language is English, in this chapter, we will start with discussing literacy research conducted in English. When discussing literacy models, each section will include studies investigating either monolinguals or bilinguals learning languages other than Arabic. The studies discussed will be limited as much as possible to studies on children in primary education, but since the skills acquired in the kindergarten stage can sometimes have an impact on literacy later on, some studies on kindergarten will be discussed, particularly of skills acquired earlier in life such as phonological awareness. Research on the Arabic language will be dealt with in Chapter 3. Then bilingualism will be investigated in general, along with giving some background information on teaching English as a second language in Kuwait (Arabic teaching context will be discussed in Chapter 3). Finally, this chapter will discuss literacy predictors used in the current study.

Models of Literacy

In this section, the models of literacy used to form the base of the current research will be discussed in detail. The focus will be on the Simple View of Reading (SVR) as one of the models that have been used to explain, not only word reading but also reading comprehension, across many languages, for monolingual as well as bilingual reading skills. For example, for Persian-English bilinguals see: Ghaedsharafi and Yamini (2011), for Dutch as a first and a second language see: Verhoeven and van Leeuwe (2012), for Spanish-English bilinguals, see: Gottardo and Mueller (2009), and for English second language learners whose mother tongue was Punjabi, Gujarati, Tamil, Cantonese or Portuguese, see: Farnia and Geva (2013). However, to understand the SVR, we will discuss other models as well, and we will return to these models for further discussions in Chapter 7. For example, both the developmental models of reading and the dual route model will be discussed in this chapter. Then, writing models will be discussed, focusing on key models relevant for the current work. Although the present study investigates both reading and writing, the writing models will be discussed briefly since most of them were developed based on the reading models. Finally, the literacy predictors used in this thesis (based on the previous models) will be briefly discussed.

The Simple View of Reading (SVR)

The Simple View of Reading (Gough and Tunmer, 1986; Hoover and Gough, 1990) is the main model the current study is based on. Although the model is built on data that is mainly derived from the English language, it is the best model to describe the processes underlying reading since it has been tested across both alphabetic and non-alphabetic orthographies (Aaron, Joshi and Williams, 1999; Florit and Cain, 2011; Joshi, Tao, Aaron and Quiroz, 2012). The model describes both word level and text level cognitive processes in a way that differentiates between comprehension processes and decoding processes. The idea behind it is that both decoding and listening comprehension are important for reading comprehension. Therefore, it presumes that when children learn to read, they incorporate two types of skills: those related to their ability to decipher the orthography they are trying to read and language skills that have been acquiring from an early age. This demarcation between the two processes enables us to define problems related to comprehension level and those related to the decoding level. On the practical level, the model enables practitioners to deal with children who have problems with decoding skills, language comprehension, or both.

Tunmer and Chapman (2012) argued for a revision to the role of vocabulary in the SVR. They argued that as well as its role as part of linguistic comprehension, vocabulary may directly contribute to variance in word recognition (decoding). Their analyses indicated that vocabulary and listening comprehension loaded onto the linguistic comprehension latent variable and that links from oral language comprehension to word recognition produce better fit indices than the standard SVR model, arguing for better vocabulary to have links with better word recognition consistent with other findings in the literature (see Quellette and Beers, 2010). The current study also considers the role of vocabulary, and its relationships to the SVR, but within a group of children learning to read and write in English and Arabic.

Research has also investigated the possibility of including a specific fluency component to the SVR (see Adlof, Catts, and Little, 2006; Joshi and Aaron, 2000;

Roberts and Scott, 2006; Silverman, Speece, Harring, and Ritchey, 2013). Some have focused purely on added naming speed (e.g. Johnston and Kirby, 2006), whereas others have considered processes such as attentional control (Conners, 2009). Since fluency is often associated with shallow orthographies (such as the Arabic language in its vowelised form), it is important to investigate the possibility of needing to add fluency to SVR when considering Arabic learners. One of the models that added fluency to the SVR is The Component Model of Reading (CMR) as proposed by Joshi and Aaron (2000). This model argues for influence on the acquisition of literacy to be organized into cognitive, psychological, and ecological domains. The cognitive domain is the focus of the current research, and, therefore, will be the focus of this brief overview (further discussion of the psychological and ecological domains can be found in Aaron, Joshi, Gooden and Bentum, 2008). In common with the SVR, the cognitive domain has two components; word recognition (which includes the ability to decode written words automatically) and comprehension. Similar to the SRV, the two components of the cognitive domain are relatively independent, and, therefore, poor readers can be categorised into more than one type: poor decoders but good comprehenders (dyslexics), good decoders but bad comprehenders (hyperlexics), and poor decoders and comprehenders (garden-variety). In the CRM, decoding is treated as a basic requirement for word-recognition, with sight-word reading emerging as an important aspect of word recognition around Grade 4. At this point, sight-word reading can be considered as speeded up: Decoding + Speed = Sight-Word Reading (Joshi and Aaron, 2000). Whether fluency is a necessary component of a reading model is still debatable, though, and requires further investigation in a range of different language contexts: for example, can independence between decoding and speed lead to separable poor readers as does the separation of decoding and comprehension?

The current work considers both fluency and speed of processing in relation to the SVR. The nature of the languages of the study makes it important to investigate both. The Arabic language (as will be discussed in Chapter 3 in more detail) has two forms: one fully vowelised and one non-vowelised. When investigating speed in relation to reading, it is vital to study it at both the word level and the text level. At the word level, the speed of processing is usually considered alongside "automaticity". La

Berge and Samuels (1974) explain automaticity as processing input rapidly and automatically without the need to focus attention. They explain that this process needs training (or practice), and that in reading it eventually implies automaticity in processing visual words, retrieving their meaning, and the transition between different processes. At the text level, the speed of tackling written text is usually discussed in terms of "fluency". Fuchs, Fuchs, Hosp and Jenkins (2001) define fluency as translating text into spoken language in an effortless manner, which can be indexed by assessing words read correctly per minute. They also consider fluency as an indicator of basic reading competence. However, these terms are somewhat inter-changeable. For example, automaticity can be considered as an aspect of fluency – fluenct word processing suggests automatic word processing. Additionally, Rasinski and Samuels (2011) argue that both automaticity and prosody as the main components of fluency are useless unless the reader engages comprehension. Therefore, both automaticity and fluency are indicators of effortless and smooth reading. While automaticity might be more likely to be associated with effortless processing at the word-recognition level, fluency may be better seen as also indicating a higher level of processing which allows the extraction of meaning from the text (i.e. comprehension).

While the SVR provides a reasonable explanation of skilled reading in individuals it does not, however, describe how decoding and listening comprehension interact developmentally. For example, the contribution of decoding and linguistic comprehension components in the model change at different developmental stages, or with learning/experience. Children at early stages of learning seem to focus on word level reading whereas later, once decoding skills have improved to a sufficient level, language-related factors become more significant in comprehension (Adlof et al., 2006). It is, therefore, important to discuss the developmental models of literacy in order to understand the longitudinal changes.

Developmental Models of Reading (Stages Models)

An overview of the stage models of reading discussed below would consider reading acquisition as divided into three basic stages: an initial logographic stage, involving a gestalt visual approach, which is not the focus of the current research as it is considered used by beginning readers; a second is a phonological decoding stage, which is relevant to the current study; and a final orthographic stage, which also requires consideration in the current work. Children in the current study are in Grade 3, and are followed through to Grade 4, which means they are most likely in stage 3 or transitioning from the phonological decoding stage to the orthographic stage. A consideration of the changes that may be taking place across these two stages is important, since the skills that contribute to literacy may vary across different stages.

Frith (1986) proposed a three stage model (based on previous work by Marsh, Freidman, Welch and Desberg, 1981) that focuses on the strategies that the reader has to master to deal with the written word. The logographic stage is considered a visual phase during which the child uses the strategy ofrecognising the word based on salient visual-graphic features (e.g. first letter). In the alphabetic stage, the child uses phoneme-grapheme correspondence rules sequentially, depending on the letter order in the word to decode words from written letters, or groups of letters, to corresponding sounds (i.e., a sounding out strategy). In the orthographic stage, the child recognises important orthographic units within words to support reading – these may include morphemic parts of a word allowing the word to split into its component morphemes (e.g. signature=sign+ture) – hence words may be recognised and pronounced via analogies with other words. An alternative model proposed by Seymour and Macgregor (1984) relates development to the construction of three different types of internal lexicon. The first is based on visual features, the logographic lexicon, which discriminates among words within a known vocabulary on the basis of whatever visual features appear functional. A second lexicon, the alphabetic lexicon, is based on grapheme-phoneme and phoneme-grapheme correspondences; or a "translation devise" that is specialised for recognition of individual graphemes whose elements are aligned with phonemic categories in the phonological lexicon. A third lexicon, the orthographic lexicon, is based on more complex spelling structures, which allows more direct translation from print to pronunciation.

A somewhat different model proposed by Ehri (2002) defines four "phases" that are characterised by the involvement of the alphabetic system and aim to explain the changes that occur in the development of sight word reading. These phases start with the Pre-Alphabetic Phase, which does not involve letter sound relations and relies on "visual cues" to read sight words, and can be considered similar to the logographic ideas discussed above. This is followed by the Partial Alphabetic Phase and the Full Alphabetic Phase: in these phases partial or complete connections between letters or graphemes and sounds or phonemes are formed to read sight words. The final stage is the Consolidated Alphabetic Phase when readers are able to decode words by transforming graphemes into phonemes, and they are able to retain sight words in memory by connecting graphemes to phonemes – this this latter stage may be associated with the types of orthographic processes discussed above, such as reading by analogy. Therefore, the primary difference between this model and the previous examples is that the alphabetic/correspondence strategy stage is split into sub-stages.

The stages models combined with the SVR can provide alternative explanations of literacy; however, they do not explain certain elements of reading. From the previous review of stages models, for example, it is clear that the stages models generally explain how the beginning reader develops from a fully visual (sight reading) to a more phonological (alphabetic) stage as a skilled reader, when they are capable of using phoneme-grapheme (phonological reading) relations automatically to decode words. They do not, however, include an explanation of how decoding happens versus lexical access at each stage, nor do they explain skilled reading. Therefore, the following section will discuss the dual route model as a model that provides other alternatives that explain the reading process.

Dual Route Models

The Dual Route Model (Coltheart, Curtis, Atkins, and Haller, 1993) represents the reading system of skilled reading, and shows how the individual uses both visual and phonological routes to read. The model suggests two routes for reading: the direct, or 'lexical route' and the indirect or 'sub lexical route.' When an individual reads a familiar word, they use the lexical route to retrieve the word's meaning from the mental lexicon. This process is facilitated by the reader's experience which has enabled them to build "logogens" for familiar words. This logogen is hence activated whenever the word is encountered, and therefore, its meaning is retrieved by the lexical route as gestalt or wholes. For unknown or nonsense words, the indirect route, which deals with sub-words, is activated. The reader in this case maps the letters onto sounds and blends these sounds to produce the correct pronunciation in order to retrieve meaning.

Connectionist models of reading (Triangle Model)

As discussed above, the dual route model explains how familiar words versus new words are read, but it does not explain the interaction between lexical and sublexical routes. The model proposes a "gestalt" approach to reading familiar words, versus a "bottom-up" approach to reading new words. The two routes described seem somehow "disconnected". The connectionist model of Seidenberg (2005) proposes a "connectionist network" or a "learning device" rather than "routes". This device discovers correspondences between spellings and sounds and represents their degree of occurrence across words. Processing involves activating units corresponding to an input pattern, such as the word's spelling, and letting activation pass to output units that represent meaning or pronunciation. Hence, these units represent orthography (spelling), phonology (derived from pronunciation and sound), and semantics (meaning), and are mapped together in a way resonant of the way lexicons are linked in the developmental model by Seymour and Macgregor (1984) discussed above.

The Dual Route Cascaded Model

This model brings together many of the features of the models discussed above, including features of connectionists learning units, and processes similar to those described in both the dual route model and the triangle model. According to Coltheart, Rastle, Perry, Lengdon and Zeigler (2001) the model consists of three routes: the lexical semantic route, the lexical nonsemantic route and the grapheme-phoneme correspondence route. Each route is composed of a number of interactive layers comprised of sets of units in much the same way as a connectionist model. The lexical non-semantic route generates the pronunciation of a word through letter units that activate a corresponding word entry in a phonological lexicon, which in turn activates a phoneme-based pronunciation. Activation of visual features, and corresponding letter units, also initiates the grapheme-phoneme correspondence route. In contrast to the previous route, correspondence rules are processed sequentially, rather than in parallel as in the lexical non-semantic route. Rules are searched until an appropriate rule is found to convert a letter/grapheme into a phoneme. The process continues until either the letter string is named or the final position in the letter units is reached. The lexical semantic route works through a semantic system, with semantic representations, and is analogous to the direct lexical route in the dual route model (Coltheart et al., 2001, p. 213-217).

Hence, this cascade model incorporates many of the features of word reading that the other models in this section of the thesis have covered. However, although this model is useful in considering those processes that support word recognition, it is less useful in determining the processes that are required for comprehension of connected text. The following provides some insights into the links between these word recognition focused models and the processes involved in comprehension.

Interactive Compensatory Model

The interactive-compensatory model proposed by Stanovich (1984) considers "the assumption that deficiencies at any level in the processing hierarchy can be compensated for by a greater use of information from other levels, and that this compensation takes place irrespective of the level of the deficient process" (Stanovich, 1984, p. 15). The reader can use contextual cues to support ongoing word recognition, as well as facilitate text comprehension. Such contextual effects are mediated by two mechanisms that may operate simultaneously, but that have different properties. One is an automatic spreading activation process that operates in semantic memory and is fast acting, uses little cognitive capacity, and has the effect of facilitating word recognition processes. The other mechanism involves predicting words from context and operates slowly, utilises attentional capacity, and can lead to both facilitation and inhibition of word processing. Therefore, in the latter case, less capacity available for comprehension and text integration processes. Hence, word processing based on automatic processing of word features or automatic spreading activation are more likely to lead to better text understanding (Stanovich, 1984, p. 15).

The Orthographic Depth Hypothesis

The relationship between the literacy models discussed so far and the current study should be better understood taking into consideration how different orthographies can play an important role in literacy development. The orthographic depth hypothesis explains this relationship in detail.

Katz and Frost (1992) propose that variations across orthographies in the relationship between graphemes and phonemes lead to processing differences in naming and lexical decision. Those orthographies with relatively simple relationships between letters and sounds are considered to be shallow orthographies and more easily support word recognition processes that focus on phonological decoding. In contrast, deep orthographies do not have simple relationships between letters and sounds and require the reader to process printed words by making more use of larger units of information, such as morphology via the word's visual-orthographic structure. Katz and Frost suggest that the use of assembled phonology should be more prevalent when reading a shallow orthography than when reading a deep orthography; though at least some dependence on phonological coding for the process of reading should occur in any orthography. Hence, the processing of words via different routes to meaning and pronunciation may depend on the type of orthography, with differing orthographies potentially showing variations in the dependency on one route over another. This may also relate to the development of these routes, with some orthographies leading to earlier use of strategies related to phonological decoding than others, or progressing through an alphabetic stage faster than might be expected based on data from a deep orthography. Finally, the influence of comprehension strategies may vary with orthographic depth: shallow orthographies may lead to faster development of decoding and hence earlier influences of linguistic comprehension, whereas a deep orthography may require greater use of contextual cues to support word recognition processes. Although all of these potential differences cannot be assessed in one study, additional data investigating the development of reading and writing across languages with different orthographies should inform these debates and support further theory development.

Writing Models

The previous review of reading models shows that the main skills involved in reading can be categorised into two main groups: those related to word recognition level, and those related to comprehension level. The models also indicate how these two levels can interact to reach comprehension. Writing process, on the other hand, requires encoding ideas into written text, a process that incorporates additional skills to generate ideas, organize them, and transform them into written text. In their model, Hayes and Flower (1980) identified four interleaving cognitive writing processes, which included planning (generating ideas, organising them logically, and setting goals), translating the plan into text expressing the intended context, reviewing the produced text and correcting errors, and monitoring which includes metacognitive processes that link and coordinate planning, translating, and reviewing (cited in Deane et al., 2008). Flower and Hayes (1981) describe the translating process as the process of putting ideas into visible language. This process, according to Flower and Hayes (1981) is demanding for children and inexperienced writers. Having to pay conscious attention to spelling and grammar can make the task of translating interfere with the more global process of planning. Other researchers also suggest that lower-level literacy skills (e.g. decoding and spelling), are vital for higher-level literacy skills (e.g. composing and organization of ideas), and that automaticity of lower order skills (which is acquired by children around second or third grade) is critical to higher order cognitive processes (Juel, Griffith and Gough, 1986). The Simple View of Writing argues that writing can be represented by transcription skills and self-regulation executive functions that enable the goal of text generation (Berninger, Vaughan et al., 2002). Transcription primarily entails processes of spelling and handwriting (or typing), similar to the ideas proposed by Flower and Hayes above (see also Hayes, 2012). Self-regulation strategies include goal setting and planning, organising, self-monitoring and revising, (see discussions in Graham and Harris, 2000). Given the focus of the current study on relatively young writers, the primary area of consideration will be the transcription processes related to translating a word into a written form (i.e., spelling). However, forming a coherent text requires the combination of translation and regulatory processes and, therefore, this aspect of writing will also be considered in the present research.

Bilingualism

Although investigating reading and writing across orthographies within the same group of children has advantages in terms of controlling differences that may occur between groups due to differential learning experiences, it does require additional considerations of the development of two languages within the same child. Hence, views about, and theories of, first and second language development, or bilingualism, need to be considered in addition to theories about cross-orthography development.

There are several definitions of bilingualism; however, for the purpose of this study, a focus will be given to the views proposed by Bialystok. Bialystok (2001) defines bilingual individuals as those who are able to speak two (or more) languages to some level of proficiency. In her review on bilingualism, Bialystok (2010, p. 561) states that both monolingual and bilingual children acquire language in the same way, but they differ in the outcomes. Bilinguals may mix languages (i.e., their first or second language), even in situations where only one of the languages is needed. Furthermore, on average, bilinguals may have a smaller vocabulary in each language than comparable monolingual speakers of that language; however, their combined vocabulary may be larger than that of the comparable monolinguals. Hence bilingual children are likely to enter the process of literacy learning with a smaller vocabulary than their monolingual peers learning the same language. In contrast, differences between young monolingual and bilingual children in phonological awareness may be relatively small and, given appropriate learning opportunities, those that are found pre-reading will likely disappear once instruction has begun. However, as for monolingual children, literacy acquisition, will depend on the type of writing system in acquired by the individual: for example, differences are likely between alphabetic (e.g., English) versus character-based (e.g., Chinese) systemsthat may lead to differences not only in acquisition of the two writing systems that are consistent with the findings for different groups of monolingual children, but also to varying interactions between the writing systems as development progresses. These differences will be elaborated more in this section when discussing the Linguistic Coding Differences Hypothesis.

Alternative perspectives about bilingualism focus on "proficiency" (for example, Cummins' threshold and developmental interdependence hypotheses). Whereas Bialystok's (2002) definition of bilingualism suggests that bilinguals should be competent, the threshold hypothesis (Cummins, 1979) assumes that a certain "minimum or threshold level of competence" in a second language is necessary for cross-language influences to be positive. If a bilingual child attains only a very low level of competence, their interaction through that language is also likely to be limited. Any advantages available from language use are therefore also likely to be limited. Cummins proposes two potential thresholds. Attainment of a lower threshold level of bilingual competence should be sufficient to avoid negative consequence of learning two languages at the same time. However, attainment of a higher level of bilingual competence should lead to accelerated growth produced by enriched language use (Cummins, 1979).

The developmental interdependence hypothesis of Cummins (1979) argues that the level of L2 competence attained by a bilingual child will be, at least partially, a function of the competence developed in LI at the time when intensive exposure to L2 begins. When L1 vocabulary and concepts are promoted by the child's linguistic environment, then intensive exposure to L2 is likely to result in high levels of L2 competence at no cost to L1 competence. However, if LI skills are less well developed, intensive exposure to L2 may impede development of L1which may, in turn, limit the development of the L2 (Cummins, 1979). This perspective is partially consistent with Bialystok's (2002) view that vocabulary size, and hence the proficiency level of bilinguals, will be affected by first language competency. The developmental interdependence hypothesis suggests that second language proficiency may be considered a continuation of first language competence, which can lead to positive or negative influences depending on competence.

The final hypothesis that we should consider here is the Linguistic Coding Differences Hypothesis by Spark and Ganschow, (see discussions of this perspective in Spark 1995). Similar to Bialystok and the developmental interdependence hypothesis, this theory suggests that foreign language learning is built upon native language skills. Phonological, syntactic and semantic skills serve as the foundation for successful foreign learning. Such *"basic language learning mechanisms"* support both native and foreign learning, and problems with one language skill (for example, phonological processing) are likely to have a negative effect on both language systems. The model originally aimed to explain the difficulties learning disability students faced with foreign (or additional) language learning, but was later extended to typically-developing children who learn a foreign language. They postulate that children who have a phonological processing deficit (particularly phonemic awareness) will show an immediate negative effect in their learning of a foreign language, whereas children who have a semantic deficit will show difficulties later in the foreign language learning process. Therefore, while Cummins argues that proficiency in first language transfers to second language, Spark and his colleagues argue that deficits in mother tongue adversely affect foreign language learning. Furthermore, while Cummins focuses on the role of education in foreign language learning, and the time foreign language learning starts, Spark focuses on the natural abilities of the individual that might affect first or second language alike.

Background of English Teaching in the State of Kuwait

English instruction in the state of Kuwait starts at the kindergarten level. It is mainly auditory rather than written at this stage, and depends highly on games and nursery rhymes. Students start studying a course-book at Grade 1 primary (Fun with English), but this is still mainly through pictures, songs and simple spoken words up to Grade 2. It is not until Grade 3 of primary school that students start studying the English language in a more structured manner that includes literacy. From Grade 3 on, course-books cover all language skills: reading, writing, listening and speaking. Children start learning the structure (grammar) of the language in more depth. This teaching of the language continues through Grades 4 and 5, the final years of primary school. At the intermediate stage of the Kuwaiti education system (middle school), students study English for four years, using 'Target English' course-books. At the secondary level, students study the language for three more years using 'Over to You' course books. In the primary, intermediate and secondary stages, students study typically English on a daily basis.

Teachers of English in government schools (where the study is conducted), are mainly Arabs: Kuwaitis, Egyptians, Syrians, Jordanians, Lebanese, Tunisians, Moroccans, and sometimes Indians (though Indian teachers work only in secondary stage). The Ministry of Education's policy when hiring teachers to teach English is that all teachers must be qualified in teaching English as a second or foreign language, and they must also have an overall grade of "Good" in their undergraduate certificate, and an educational qualification (whether, undergraduate, postgraduate, or both). All teachers are also supposed to undergo a written exam and an interview, to ensure that their level of English is suitable for teaching school children. In addition, the Ministry provides regular training courses for teachers, including mandatory training when working as a school teacher for the first time. Many activities are also conducted to ensure that teachers are up to date with information and trends in the field, including seminars, workshops, lecture, and conferences. Despite the range of procedures, these do not guarantee that the linguistic knowledge of teachers is up to the par. However, the reasons for a lack of linguistic proficiency among teachers in Kuwait, and the potential effects of this on children's literacy development are beyond the scope of the present study.

Language/Literacy Predictors

In this sub-section, the skills (processes) targeted in this study will be introduced. These will be considered in relation to the previous discussion of literacy models and bilingualism, as well as previous studies suggest their important in explaining variability in the levels of reading and writing shown by children from various language backgrounds.

Decoding Skills

Decoding and word recognition can be used interchangeably to refer to the process of extracting information from written words in order to locate an entry in a mental lexicon and provide access to semantic information related to the word (e.g. Stanovich, 1982). In the current study, word decoding refers to the ability to translate a letter form into an appropriate pronunciation using measures of non-word reading (Neilson, 2009).

As explained previously in the SVR, Gough and Tunmer (1986) suggest that a skilled decoder is an individual who can isolate written words quickly, accurately, and silently. However they do not equate decoding to word recognition. According to Gough and Tunmer, decoding connotes the use of letter-sound correspondence rules. Although word recognition in an alphabetic orthography is fundamentally dependent upon knowledge of letter-sound correspondence rules, this is not sufficient for word recognition since it cannot in itself lead to the reading of irregular words (*pint* and *yacht*), or orthographically ambiguous words (*bead* and *bread*). However, knowledge of letter-sound correspondence rules is important to enable the reader to recognise the majority of English words (Gough and Tunmer, 1986).

The above perspectives have led to the word recognition component of the Simple View has been measured by nonword decoding (e.g. Hoover and Gough, 1990; Joshi and Aaron, 2000), by real word reading accuracy (e.g. Dreyer and Katz, 1992), or by a combination of both (Aaron, Joshi and Williams 1999; Catts, Adlof, Hogan and Weismer, 2005). In the current study decoding and visual word recognition will be distinguished based on the argument that decoding can explain the influence of grapheme-phoneme correspondences while written word recognition can assess the process of accessing words that are in an individual's lexicon. Decoding can be assessed by asking individuals to name pseudowords: letter strings that follow the orthographic rules of the language tested, but which do not have a lexical entry or link to semantics, meaning that pronunciation must be derived from links between graphemes and phonemes, or by analogy with a known word. Word recognition, on the other hand, can be assessed by the reading of real words that have an entry in the lexicon of the individual – for children, higher frequency words may be needed to ensure a sight-word entry is available.

Vocabulary

Vocabulary knowledge is important both in learning to recognise individual words and in text comprehension (McKeown, Beck, Omaanson and Perfetti, 1983; Nation and Snowling, 1998). The reader needs to know the meaning of individual words that make up a written text to fully understand that text. Furthermore, research shows that the relationship between vocabulary and reading will likely be reciprocal across development (Beck, Perfetti and McKeown, 1982; Nation, Clarke, Marshall and Durand 2004). For example, Ricketts, Nation and Bishop (2007) investigated literacy levels and vocabulary in English-language children aged 8 to 10 years. They found that reading skills were predicted by oral vocabulary. However, the findings indicated that oral vocabulary predicted reading comprehension and exception word reading but it did not predict text reading accuracy, non-word reading or regular word reading. Similarly, Muter, Hulme, Snowling and Stevenson (2004) argued based on data derived from a two-year longitudinal study of English children's first two years of learning to read, that vocabulary knowledge plays a significant role in reading comprehension more so than the development of word reading accuracy.

Evidence on the importance of vocabulary as a predictor of literacy also exists in bilingual research. However vocabulary development for bilinguals is different from monolinguals. For example, Bialystok, Luk, Peets and Yang (2010) analysed the combined results of studies that in total involved 1738 participants of which 966 were bilinguals. The bilingual children spoke a wide range of different languages at home, but all were being educated in English, and all continued to use both their first and second language every day. Results indicated that for all the ages included in the sample, there is a substantial and persistent delay in vocabulary acquisition for the bilingual children based on expected levels of vocabulary found in monolingual children using the same language.

Although studies show that the vocabulary development within a specific language is generally delayed for bilinguals, some studies show that vocabulary is still a predictor of children's literacy levels. For example, a study by Burgoyne, Whiteley and Hutchinson (2010) investigated the developmental progression (from Grade 3 to 4) of English reading among 39 bilingual learners whose first language was of South-Asian origin, in comparison to 39 monolingual peers. The results showed that vocabulary did not make a significant contribution to reading comprehension for the monolingual children, regardless of the order of entry with other variables in the study. For bilingual children, however, vocabulary emerged as a significant predictor of Year 4 reading comprehension when entered after reading accuracy. Similarly, Mancilla-Martinez and Lesaux (2011) found that for children whose home language was Spanish but whose classroom language was English, English vocabulary was related to reading comprehension outcomes and showed a faster growth rate than that for Spanish vocabulary. Hence, vocabulary can play a part in predicting variability in reading, particularly reading comprehension, in bilingual learners, although the precise interactions between vocabulary levels in each language and reading are still to be determined

Phonological Skills

Research shows that phonological processing skills are an important component in the ability to translate a written word or letter string into an appropriate pronunciation (see Goulandris, 2003; Snowling, 2000; Stanovich, 1988) and that phonological deficits are related to literacy problems (see: Snowling, 2000). There is evidence to support the core role of phonology from research on pre-readers (e.g. Blair and Savage, 2006; Puolakanaho et al., 2008; Puolakanaho, Poikkeus, Ahonen, Tolvanen, and Lyytinen, 2004; Wood and Terrell, 1998), and adults (Nergård-Nilssen and Hulme 2014). There is also evidence from cross-language comparisons (e.g. Smythe et al., 2008; Ziegler et al., 2010), including research on non-Latin-based scripts, such as Hebrew (Russak and Saiegh-Haddad, 2011) and Chinese (Ho and Bryant, 1997).

Wagner and Torgesen (1987) identify three primary phonological processing skills: *"phonological awareness*" (phonological sensitivity), "*phonological recording in lexical access*" (rapid naming), and *"verbal short-term memory*". For a comprehension investigation of phonological processing, measures of each of these elements will be necessary.

Phonological Awareness

Phonological awareness refers to an individual's recognition that oral language can be divided into smaller components of verbal sounds and that these smaller units of sound can be manipulated to form new sound combinations. Spoken language can be broken down in different ways. Sentences can be broken down into individual words. Individual words can be broken down into syllables, onsets and rimes, and individual phonemes. A syllable can be considered are made up of an onset and rime, or even a set of phonemes. Even a rime can be thought of as comprising more than one phoneme. Being phonologically aware means having a general understanding of these levels of language.

Although the above discussion has focused on the effects of phonological awareness in literacy, learning to read and write also has an effect on phonological awareness development; that is, the relationship between learning to read and developing phonological awareness is reciprocal. For example, most children achieve only minimal levels of phoneme awareness prior to formal instruction in reading and writing, but this should typically develop quickly following the onset of literacy instruction for children learning to read a relatively transparent alphabetic orthography (such as Arabic in its fully vowelised form). Facilitative effects between literacy and phonological awareness seem to be strongest when children are learning the relationship between graphemes and phonemes, which can take 1 to 3 years depending on the orthographic transparency of the written language (Anthony and Francis, 2005, p. 258). Chall (1987) explains that this early stage, when the child learns letter-sound correspondences (which she calls the "decoding" stage), extends from Grade 1 to the beginning of Grade 2. The child then begins to use decoding and incorporate fluency to read words by Grades 2 and 3 (which she calls the "Fluency" stage). The child then transitions from these early "learning to read" stages to Grade 3 and beyond or to "reading to learn stages" (see also Indrisano and Chall, 1995). Based on this, the children in the current study should be undergoing the transition from the early stages of learning the basic phonological skills, to a stage when they are supposed to apply those basic letter-sound correspondence skills automatically in order to read more fluently and concentrate more on "message" rather than the "medium". However, the move from vowelized text (that includes short vowel sound markers) to non-vowelized text (which excludes short vowel diacritics) around grade 3 in the current context may disrupt this predicted transition process and it remains to be determined the extent to which the expected development process occurs within typical Arabic learners who also experience this change in orthographic form.

Evidence argues for the importance of phonological awareness as one of the skills that can predict reading from an early age. In study assessing children from kindergarten through to third-grade and then onto fourth-grade, Wagner et al. (1997) tested the relationship between phonological processing abilities (phonological awareness, phonological memory, and serial naming) and word-level reading skills. Their analyses indicated that individual differences in phonological awareness, naming, and vocabulary influence subsequent development of word-level reading at each time examined. These data indicate that the influence of phonological awareness is not limited to beginning readers but extends to children in fourth grade. The stability of individual differences in phonological processing abilities from kindergarten through to fourth grade also supports the argument for early screening of phonological processing abilities as a way to identify children who are at risk of future reading problems.

As indicated in the preceding review of the literature, the importance of phonological awareness in reading acquisition has been established across a range of languages, and in languages other than English as well (see also: Veii and Everatt, 2005, on Herero; Verhagen, Aarnoutse and van Leeuwe, 2008, on Dutch; Wood and Terrell, 1998, on English preschool children). There is also research arguing for the role of phonological awareness in reading acquisition when the instruction is in a second language (e.g., Bialystok, Majumder and Martin, 2003, on Spanish-English and Chinese-English bilingual children; Chiappe and Siegel, 2006, on English as a first and second language). Evidence from cross-language transfer studies shows that phonological awareness skills of one's first language predict literacy skills of a second language and vice versa. This is referred to as "Cognitive Retroactive Transfer of Language Skills"(e.g., Durgunoglu, Nagy and Hancin-Bhatt, 1993, on Spanish-English bilinguals; Wang, Perfetti and Liu, 2004, on Chinese- English bilingual children).

Therefore, phonological processing can predict literacy in both monolingual and bilinguals children. However, the role of phonological awareness in literacy differs according to the transparency of the orthography and different levels of phonological ability may be necessary to acquire good literacy skills in different orthographies. Furthermore, although measures of phonological processing, such as relatively simple syllable and rhyme tasks, may be indicative of early phonological skills, other more complex measures that require manipulation and retention of phonological forms may be needed to assess mature phonological skills (see Smythe et al., 2008). Since phonological awareness develops faster when learning a more regular orthography, though, then the point at which more complex measures will be needed to assess phonological awareness skills may also depend on the orthography learnt by the child.. Therefore, more research is needed to investigate the role of phonological awareness in literacy, particularly for bilingual children learning to read in different orthographies that may vary in orthographic transparency.

Rapid Automatized Naming (RAN)

This section will focus on rapid automatized naming (RAN) as one of the main abilities that have been used to describe the development in shallow orthographies. In RAN tasks, participants are asked to name a number of different stimuli (such as letters, digits, colors, or objects) each of which is repeated several times in the presentation of the stimuli. Serial naming speed requires the transfer of visual stimuli (object, numeric, and letters) to whole word phonological codes. The repeated presentation of items makes access different from written word access as in the dual route model, where phonological forms apart from those related to whole word would most likely be part of normal processing. However, studies on RAN are contradictory in their findings, particularly concerning the time when RAN starts being predictive of literacy and what exactly it is predictive of. Studies also demonstrate different findings across orthographies. Therefore, we will present these studies and their contradictory findings.

There are several reasons why relationships between RAN and reading may occur in both typically developed and reading-disabled individuals (see discussions in Georgiou, 2008). One has already been discussed in the previous sub-section of this introduction. This proposes that RAN should be considered another manifestation of phonological processing– as a feature of *"phonological lexical access"* (see Wagner and Torgesen, 1987). This view (which was a starting point for the current research) argues that rapid serial naming tasks are measuring individual differences in the efficiency with which visual symbols are recoded into their phonological representations. As discussed in the previous sub-section of this thesis, phonological awareness, phonological memory and phonological lexical access should all be considered aspects of phonological skills that are related to reading ability (Logan, Schatschneider and Wagner, 2011). Hence, given that RAN is measuring phonological lexical access, then scores on such tasks should be related to (and predictive of) reading ability in children.

However, there are alternative explanations about RAN that should also be considered (Georgiou, 2008). For example, Wolf and her colleagues (Wolf and Bowers, 2000; Wolf and O'Brien, 2001) have argued that RAN is an index of the quality of orthographic representations. Hence, RAN might be better considered as an aspect of orthographic processing rather than phonological processing; and reading difficulties may be associated with phonological weaknesses and rapid naming weaknesses independently (Wolf and Bowers, 2000). This view would argue for RAN to be considered separately from phonological awareness measures in analyses. Equally, it is also possible that RAN and reading are related because they both rely on speed of processing (see discussions in Georgiou, 2008). Under this perspective, RAN should be treated as a separate aspect of processing from both phonological and orthographic processing – indeed, from reading and language as it is a function of a general underlying processing system.

Whichever (if any) of the above views proves to be correct, they all argue for relationships between RAN and reading. Consistent with this, research, primarily on English language monolinguals, has found that RAN is related to literacy (e.g., Catts, Gillispie, Leonard, Kail and Miller, 2002; Christo and Davis, 2008). However, the level of prediction provided by RAN and its specific point of influence are still debated. Some studies suggest that while phonological awareness is related to beginning reading levels, RAN becomes more prominent with increasing reading experience (see Kirby, Parrila and Pfeiffer, 2003). Other studies claim that the influence of phonological awareness can be found in older, more experienced readers and extends across school grades (particularly in the primary school years), in contrast to RAN where the effects are short term (see Wagner et al., 1997). Such findings suggest that RAN is important from an early age, whereas others state that it is not important until after the first two years of school. Furthermore, some findings suggest that RAN is more important than phonological awareness, while others show that phonological awareness is a better predictor of literacy. Hence, there are still contradictory findings in the literature on the relationship between RAN and reading, particularly when considering more longitudinal findings.

Studies comparing monolinguals and bilinguals on RAN have identified differences between these groups, with bilinguals typically showing evidence of longer naming times than monolinguals (see Bialystok, Craik and Luk, 2007). These slower times seem more likely to be attributable to the additional time required to retrieve the name of a target item rather than its meaning since a classification task, in which objects were categorised as natural or human-made, showed little difference between monolinguals and bilinguals (Bialystok, Craik and Luk, 2007). Bialystok (2010) argues that the bilingual children differ from monolinguals in the ease or fluency with which linguistic items can be retrieved and that differences are not simply a manifestation of poorer vocabulary.

Goswami (2000) argues that the transparency of the orthography that the child is learning influences how rapidly he represents phonological information at the level of the phoneme. Relatively rapidly acquisition of phoneme-level representations should occur with a relatively transparent orthography (such as Greek or German), whereas less transparent orthographies (e.g., English or French) will be related to slower to acquisition of phoneme-level representations. Faster acquisition of phonological awareness in orthographies that have a more direct letter-sound relationship will mean that more complex measures of phonological processing may be required to differentiate individual differences in phonological skills. Hence, given that RAN is a more complex measure (or is subject to more variability due to its focus on access time), should be a better measure of variations in phonological skills in a more transparent orthography and, consequently, a better measure of the relationship between reading and those processing skills related to RAN.

Short-term Phonological Memory

Similar to the above discussion of RAN and lexical access, research investigated the relationship between short-term memory and reading has also obtained mixed results. Short term memory typically refers to the ability to store material over a short period of time, and is capacity limited (i.e., only a specific amount of material can be stored for this brief period) (Gathercole and Adams, 1994). Phonological short-term memory is the ability to hold familiar or unfamiliar verbal material (i.e., known words that have some meaning plus made-up words that follow the phonotactic patterns of the language tested). Based on working memory models of short-term memory, the phonological system consists of a store and a rehearsal process (see Baddeley, 2003); and has been implicated in processes that lead to visual information been recoded into phonological information (Gathercole, Pickering, Ambridge and Wearing, 2004). The phonological store holds the material in a phonological code that is subject to rapid decay and the rehearsal process refreshes decaying representations in the store (Gathercole, et al., 2004). Hence, such a system can be hypothesised as being involved in reading acquisition since the task faced by the beginning reader is to: (a) decode a series of visually presented letters into an appropriate phonological form, (b) store these sounds in a temporary phonological store, and (c) blend the contents of the temporary store into a form that can be recognised as a familiar word or be produced as an accurate pronunciation. Efficient phonetic coding and successful short-term storage of these sounds will allow the beginning reader to devote more cognitive resources to the blending process, arguing for a relationship between phonological memory and the acquisition of reading skills within beginning readers (Wagner and Torgesen, 1987).

Gathercole and Baddeley (1993) proposed that children with specific language impairment perform poorly on measures of phonological short-term memory, particularly tests that require non-word repetition. Non-word repetition requires the participant to repeat meaningless sequences of speech sounds that are plausible (i.e., they are word-like) within the language of testing. This difficulty could reflect inadequate speech discrimination or output process, or could relate to poor phoneme segmentation, or a lack of experience of sound patterns (which may be related to small vocabulary size or low levels of exposure to a language, as experienced by some second language learners). Whatever the reason, this link between deficits in non-word repetition and specific language impairment has been found with monolingual English children (Archibald and Gathercole, 2006), and has also been identified among bilingual children. For example, Girbau and Schwartz (2008) found that for Spanish-English bilinguals, a non-word repetition task following the phonotactic patterns of Spanish was an accurate identifier of specific language impairment in Spanish.

However, the link with reading impairments is less clear. Although some studies have argued for a relationship between phonological short-term memory and reading ability (e.g., Jeffries and Everatt, 2004; Seigneuric and Ehrlich, 2005), others have not found such relationships. For example, Gathercole, Alloway, Willis, and Adams (2006) investigated the extent to which working memory impairments were related to the severity of difficulties experienced by six to eleven year old children with reading disabilities. Their results suggested phonological short-term memory performance was not markedly impaired in this sample of children with reading disabilities and that deficits in phonological short-term memory alone do not lead to substantial learning difficulties. Such differences in results have led to discussion about the type of measures used and the point in development when children were assessed. For example, Baddeley and Wilson (1993) have argued that the contribution of non-word repetition to the prediction of reading performance varies depending on the stage of reading and the nature of the task used to measure reading performance.

Chiappe and Siegel (2006) discuss the idea that deficits in working memory result from difficulties in encoding adequate phonological representations. Given that second-language learners experience a lack of fit between their first language phonological representations and the phonological structure of the second language that they are learning, such learners may show limited working memory performance in the second language, which might contribute to difficulties in reading acquisition (Chiappe and Siegel, 2006). Hence, despite the differences in the findings in the literature, there are still sound arguments for considering the potential contribution of phonological short-term memory to reading (and possibly writing) ability in bilingual learners.

Orthographic Skills

Orthographic processing refers to knowledge of letter patterns and the ways in which these patterns can be combined legally within the rules of a writing system. Although research focusing on the contribution of orthographic knowledge to reading success may be limited relative to that specifically looking at the contribution of phonological processing, there is evidence that orthographic processing accounts for additional variance in word recognition, text reading and reading speed over and above that contributed by phonological processing (e.g., Juel et al., 1986; Stanovich, West and Cunningham, 1991; Wagner and Barker, 1994). These findings support the belief that phonological and orthographic skills jointly contribute to reading success (Sun-Alperin and Wang, 2011). And such contributions have also been identified with bilingual readers. For example, Arab-Moghaddam and Senechal (2001) investigated the role of orthographic and phonological processing skills in the reading and spelling performance of Persian/English. Their data indicated that the predictors of reading performance were similar across languages. Both phonological and orthographic processing predicted unique variance in word reading in the two orthographies once grade level, vocabulary, and reading experience had been controlled. Both phonological and orthographic processing skills also predicted English spelling levels, though spelling in Persian seemed to be more associated with orthographic processing. These findings argue for the inclusion of measures of orthographic processing in studies of bilingual children, particularly in the current study given the similar orthographies used to those of Arab-Moghaddam and Senechal (2001); i.e., the Persian orthography is derived from Arabic.

Morpho-Syntactic Awareness

Syntactic awareness refers to the ability to understand the basic grammatical structure of a language: i.e., an understanding of the rules of grammar and the way sentences are constructed. Perfetti (1985) argues that syntactic context has the potential to allow readers to predict words. For example, 'the' should trigger a noun-phrase pattern and words that cannot complete this pattern should be rejected or inhibited. The ability to use the syntactic structure of spoken language, therefore, has the potential to support reading comprehension; although it may also support word recognition skills if the reader can use the grammatical structure of a sentence to decode unfamiliar words via the same prediction process that may support comprehension (Cain, 2007). Syntactic awareness also may help children to detect and correct reading errors through this same prediction process, thereby enhancing comprehension monitoring (Tunmer and Bowey, 1984). Consistent with these arguments, syntactic awareness has been found to be related to students' reading achievement (Layton, Robinson, and Lawson, 1998) and children's ability to correct grammatically incorrect sentences within oral language has been correlated with measures of reading comprehension (Bowey, 1986). Studies have also reported poor performance in syntactic awareness tasks in individuals with a reading disability (Tunmer, Nesdale and Wright, 1987) and children with poor reading comprehension skills show weaknesses on measures of syntactic awareness (Nation and Snowling, 2000; Siegel and Ryan, 1988). Similarly, Vogel (1974) found that syntactic skills (which included morphological ability) differentiate grade 2 dyslexic and non-dyslexic students. Dyslexic children with reading comprehension difficulties were particularly deficient in oral syntax.

Chiappe and Siegel (2006) believe that syntactic awareness is important when reading text because fluent reading requires a process of predicting words that are likely to come next in that text. Children learning to read in a second language, therefore, may experience reading difficulties due to syntactic processing skills failing to transfer from their first language to their second language (Chiappe and Siegel 2006). Such arguments are consistent with data indicating poor performance of second language learners on measures of syntactic awareness (e.g., Jongejan, Verhoeven and Siegel, 2007).

Morphological awareness refers to the understanding of the morphological composition of words, as well as the ability to reflect on and manipulate such morphological compositions (Carlisle, 1995). A morpheme is the smallest unit of meaning within a word and, therefore, morphological awareness has often been related to semantics and vocabulary. However, because meaning is conveyed in syntactic structure, morphological awareness should also be associated with syntactic awareness: knowing that the letter ‘s’ at the end of an English word is likely to denote more than one, changing the intended meaning of the text, represents both syntactic structure and morphological composition.

Studies of older children and adults suggest that morphological knowledge plays a role in reading complex words, as well as in spelling and reading comprehension, but data also indicate that knowledge of morphology is related to reading and spelling abilities even in the elementary years. For example, Carlisle (1995) conducted a longitudinal study of children moving from kindergarten to first grade and then to second grade. This study indicated that first-grade morphological awareness was significantly related to subsequent reading achievement. Similarly, a 4-year longitudinal study by Deacon and Kirby (2004) indicated that Grade 2 morphological awareness, was related to pseudoword reading and reading comprehension in later grades, though it was not related to single-word reading. Adlof (2009) reports a link between poor comprehenders and weaker performance in morpho-syntax tasks, and spelling skills have also been found to be related to morphological ability (see Nunes, Bryant, and Olsson, 2003). These findings suggest that morphological awareness is related to a range of measures associated with literacy achievement, and may be linked to literacy across a number of different orthographies (see Pittas and Nunes, 2014, on Greek; Rispens, McBride-Chang and Reitsma, 2008, on Dutch).

Studies of bilinguals also reveal the importance of morphological awareness in predicting literacy. Ramirez, Chen, Geva and Luo (2011) investigated English as a second language morphological awareness in Grade 4 and Grade 7 English language learners from Chinese or Spanish backgrounds. After controlling for nonverbal ability, maternal education, and other reading related variables, morphological awareness made a unique contribution to word reading in all the groups tested. Wolter, Wood, and D'zatk (2009) reported similar findings when testing Chinese/English bilinguals. An oral morphological production task explained unique variance in reading and spelling after controlling phonological awareness. Finally, Kieffer, Biancarosa and Mancilla-Martinez (2013) investigated contributions of English morphological awareness to English reading comprehension in Grade 6 to 8 Spanish first language learners. Morphological awareness was found to have a unique contribution to reading comprehension after controlling for phonemic decoding, sight word reading, passage reading fluency, reading vocabulary, and listening comprehension. This unique contribution did not differ significantly across the grades tested. Furthermore, morphological awareness was also indirectly related to reading comprehension via vocabulary and passage reading fluency. Overall, these studies argue for a role for morphological and/or syntactic awareness in the reading and writing development of children across a range of language backgrounds. As with the other areas of cognitive-linguistic skills identified for inclusion in this research, measures of these areas of processing will be included to inform the development of reading and writing models of Arabic learners as well as English second language learners.

Chapter Three: The Arabic Language

This chapter will describe the nature of the Arabic language focusing on the linguistic components that are going to be investigated in the current study, i.e. Arabic vocabulary, phonology, orthography, syntax, and morphology. It will highlight some of the differences and similarities between Arabic and English, which are thought to affect literacy learning in Arabic/English bilinguals. Furthermore, it will describe the Kuwaiti dialect (the dialect of the community where the current research took place), and hence shed light on the controversial case of diglossia. The reason is that according to previous research, diglossia has negative effects on literacy acquisition for Arabic children. Finally, we will review the most recent studies on Arabic literacy in last fifteen years.

Nature of the Arabic Language

It is estimated that about 200 million Arabic speakers are native Arabs from about 20 countries across the Arab world (Elbeheri, 2004). In addition, since Arabic is the language of the Holy Quran, it is used by approximately one billion Muslim people (Mahfoudhi, Everatt and Elbeheri 2011). After English, it is considered the second most widely used language (either as a first language or an additional language of use) in the world. Like Amharic, Aramaic, Maltese and Modern Hebrew, Arabic descends from 'Proto-Semitic' language which existed about the $6^{th}/8^{th}$ millennia BC. Arabic prevails mainly in North Africa and the Arabian Peninsula. Like English, Arabic is represented by an alphabetic-type orthography (writing system). The Arabic alphabet also is one of the most widely used orthographies in the world, having been adapted to various other languages such as Kurdish, Pushto, Farsi, Sindhi, Urdu, Swahili, Somali and Ethiopian (see Elbeheri, 2004; Mahfoudhi, Everatt and Elbeheri 2011).

Arabic Vocabulary

Unlike English, the Arabic words are divided into three types: nouns, verbs, and articles. The noun is any word that refers to a human, an animal, a plant, an object, a place, time, quality, or a timeless meaning. The verb is any word that refers to an action happening at a specific time. The article is any word that has no meaning unless it is related to another word, e.g. /fi:/ في (the preposition "in") (Ne'ma, 1973). The nouns of Arabic are divided into eight major types: examples include proper nouns (Mohammed) /muhæməd/ محمد, animals أسد /æsəd/ (a lion), plants (wheat) /q^mħ/ قمح, things e.g. (a desk) /mæktəb/ مكتب, adjectives (beautiful) /ʤæmi:ləh/ جميلة, demonstratives (this) /hæðæ/ هذا, relative pronouns (who) /æl'læði:/ الذي, and pronouns (I) /ænæ/ أنا. The verbs are divided into three major types: examples are the past "a complete action" (*I* read) /q^r^'ʔtu/ قرأت, present "indicates continuity" يخلص /yuxlesˤ/ (to redeem), and imperative (study) /ðæk^rə/ذاكر. Words in Arabic could be singular as (a teacher) /mu'ʕəlem/ معلم، معلمة, dual as (two teachers) /muʕəle'mæn/ معلمتان /muʕəlemə'tæn/ معلمان , or plural as (teachers) /muʕəlemæt/ معلمات ، معلمون /muʕəle'mu:n/ (Salama, 2005).

Semantic Relations in the Arabic Language

Arabic has two types of orthography: marked and unmarked. The marked orthography is the fully vowelised version with all diacritics representing short vowels added to the written text. The unmarked orthography, on the other hand, does not have any diacritics to guide the reader. Therefore, an Arabic word in context could have different meanings, and unless the reader is aware of all of the semantic connotations, it would be hard to guess the correct meaning of a word. It is then vital for a good reader to have a good range of vocabulary in Arabic in order to comprehend a text, particularly if it is unmarked. Similar to English, Arabic has synonyms, homonyms and polysemy, antonyms, and hyponymy. Some of the synonyms are from loaned and inherited words like the word تليفون (telephone) /telifɔ:n/, which is literally taken from European languages, and هاتف/hætif/, the Arabic equivalent. Other synonyms are from different language levels or environments like the word, "تموز"/tə'mu:z/, which means July, it is called "يوليو" /yɔlyɔ/in some other parts of the Arab world. Other synonyms have different affective meanings. These include groups of words that have an affective or judgmental viewpoint. In the political field, a person could be described as محافظ /muħɑfeðˤ/ (mayor), which is a positive word. However, if they are described as /rəʤʕi:/ رجعي (conservative), this connotes a negative judgment of them. Homonyms and polysemy indicate that two words can have two different meanings. An example of polysemy is the word /ʕəyn/ "عين" which can mean an eye, water spring, needle hole, or spy. Homonyms mean that the pronunciations of two different words have changed throughout time, and now they share the same pronunciation. An example of the Arabic language is the word /ku'leyəh/ "كلية" can refer to "college", a part of the university, as in /ku'leyətul'ædæb/ "كلية الآداب", or it can mean "total" or "whole" as in /q^ dˤeyatun kuleyəh/ "قضية كلية"(Hegazy,1997).

Arabic Phonology

Arab linguists have differentiated two types of sounds, consonants, and vowels. The vowels are divided into long vowels, short vowels, and semi-vowels. The long vowels are the /a:/, /u:/ and /i:/. Short vowels are the sounds that the three diacritic marks represent; ◌َ (a mark above the letter), the fat'ha /fətħəh/, which represents the short vowel /a/, ◌ِ (a mark below the letter), the kasrah /kəsrəh/, which represents the short vowel /i/, and ◌ُ (above the letter), the dhammah /dˤəməh/, which represents the short vowel /u/. Arabs considered the two letters, و /w/ and ي /y/ semi-vowels when attached with no vowel, or when the vowel preceding them is of a different type. These same letters act as consonants in words like /w^sˤlə/ 'وصل' and /yusr/ 'يسر' (Mohammed, 1998).

The Arabic language has twenty-six phonemes for consonants (ء – ب – ت – ث – ج – ح – خ – د – ذ – ر – ز – س – ش – ص – ض – ط – ظ – ع – غ – ف – ق – ك – ل – م – ن – ه). (Abdeljaleel, 1998). There are differences in the pronunciation of two similar or different phonemes in two languages; they are not always pronounced in the same way. The /t/ and /r/ sound, for example, differ in the way they are pronounced in English, Arabic and German. This difference extends within one language. In Arabic, for example, the ض /dˤ/ sound is pronounced differently in the Gulf region, Iraq, Saudi Arabia…etc. In general, it tends to be pronounced as /ðˤ/ ظ. These differences are clearer in the vowels more than the consonants (Allam, and Mahmoud, 2009).

Standard Arabic differentiates between two types of vowels only the short and long. There is no clear demarcation between the grades withtin each type since they are simply considered phonological variations that do not affect the meaning. It does not differentiate between /a:/ and /æ/ and considers them different variations of pronouncing the long vowel "ا". Therefore, it considers six vowels only, three long vowels and three short ones. However, the Fat'ha (◌َ) in the word /sˤ^b^rə/ صَبَرَ is different from the one at the beginning of the word /səmiʕə/ سَمِعَ the first one is pronounced as /^/ while the second one is pronounced as /ə/. The same thing applies to the words as /tˤɑbə/ طاب in which the ا is pronounced as /ɑ/ while the ا in /bætə/ بات is pronounced as /æ/ (Allam and Mahmoud, 2009).

The absence of the diacritics in books represents a challenge for some poor or beginning readers since they have to rely on other contextual features to understand the text. Good grammar or vocabulary knowledge might be necessary for them to extract meaning.

Arabic Syllables

Some linguists divide Arabic syllables into nine types: CV, CVV, CV, CVVC, CVCC, VC, CVV, CVVCC, and CVVCCV (Abdeljaleel, 1998). CV is a short open syllable as in /kə/ /lə/ /mə/ گ لَ مَ. CVV is a medium open syllable as in /mæ/ /næ/ /hæ/ ما نا ها. CVC is a medium closed syllable as in /qul/ /səl/ قل سل. CVVC is a long closed syllable (with a double nucleus - the vowel acts as a nucleus) as in /qɑm/ /næm/ /sˤɑm/ قام نام صام. CVCC is a long closed syllable as in /ʕelm/ /sˤʌrf/ /nəhr/ علم صرف نهر. VC is a short closed syllable that emerges when linking words in pronunciation (liaison) as in /edrus**uk**tub/ ادرس اكتب. VCC is a medium closed syllable with a double consonant; it emerges when stopping at words /esm/ /ebn/ like اسم ابن. CVVCC is a very long closed syllable that emerges when stopping at words like /ʤæ'd/ /ħæ'd/ جاد حاد جادد حادد. CVVCCV is a very long open syllable as in /ʤæ'də/ /ħæ'də/ جاد حاد. (Allam and Mahmoud, 2009).

Words in the Arabic language can be monosyllabic as in /min/ من. They can have two syllables as in /ʔiʤlis/اجلس, three syllables as in /sˤɑʔimɔn/ صائم, four syllables as in /mədrʌsətun/ مدرسة, five syllables as in /munæqəʃætun/ مناقشات, six syllables as in /mutəsæbiqatun/ متسابقات, or seven syllables as in /istifsɑrɑtihinə/ استفساراتهن (Abdeljaleel, 1998). The number of syllables can increase or decrease depending on the position of the word in the sentence or context. When stopping at the word, the final vowel is deleted. Therefore the number of syllables is decreased, while when linking in context the final vowel is pronounced which adds an extra syllable to the total number of syllables. This complex nature of the Arabic language is problematic when trying to spell or read, particularly for beginners or for any reader of unmarked texts, when diacritics disappear, and one has to depend on the syntactic information to guess.

An example of how these rules operate in Arabic is the word: استقرأناكموها /istəqrəʔnækumuhæ/. The word consists of five segments: one root, three clitic pronouns, and 4 morphemes, the second of which means 'read':

قرأ verb (root) means read

است prefix means to make or ask someone to do something

نا a clitic pronoun indicates that the verb is conjugated with 'we'

كم a clitic pronoun and a suffix that refer to the plural masculine object pronoun ' you'

ها a clitic pronoun and a suffix that refer that refers to singular feminine object pronoun 'it'

و extra letter for pronunciation (to prolong the short/u/ vowel to be /u:/)

The whole word means 'we asked you to read it for us'.

Although Arabic is a highly regular writing system, this word may present problems of visual complexity, due to the diagraphic markers, and to auditory short-term memory because of its fusional (infelcting) nature. This example illustrates that there is a range of potential cognitive-linguistic influences on the acquisition of skilled word recognition.

Arabic Orthography

Arabic is considered a consonantal "Abjad" which is read and written from right to left. The Arabic alphabet consists of 28 letters and 34 phonemes, and it is phonemic in nature. The Arabic script consists of 17 characters. Dots are added to some of these characters to form letters, which makes the total letters of the Arabic alphabet 28 (Mahfoudhi et al., 2011).

In vowelised or marked text, Arabic is considered a shallow or transparent orthography since the relationship between letters (symbols) and their sounds is predictable. In the non-vowelised text, it becomes a deep or opaque orthography; since short vowel sounds have to be inferred from the context. Non-vowelised text requires the mature reader to use syntactic awareness, vocabulary, and contextual interpretations to read individual words accurately. In addition, different derivatives (i.e., nouns, verbs, and adjectives) are formed by adding prefixes, suffixes or infixes along with certain diacritic marks to the root letters of a word. Adding diacritic marks to a word ending changes their grammatical functions: e.g., subject, object, etc. The reader, therefore, has to deduce short vowels and sometimes function depending on the level of diacritical marks included in the text. Similarities between words and letter, in addition to homographs, can make it a demanding process for beginning or poor readers (Abu-Rabia, 2007).

In Arabic, the graphic shape of the letter also changes according to its position within a word; initial, medial, final or isolated. This poses a further challenge to the reader (Abu-Rabia 2007). For instance, the letter "ه" in its isolated form, is written as "هـ" in the initial position, "ـهـ" in medial position, and "ـه" in final position. Reading a fully marked text can; therefore, be cognitively demanding for a beginning reader, who has to incorporate many rules to extract meaning from text. This includes, recognising different shapes of letters, and recognising the different short vowels under, in and above them. Conversely, reading unmarked text requires experience and a reasonable level of inference to determine word pronunciation and meaning to avoid decoding, letters of the same shape which delays comprehension and/or reading fluently (Abu-Rabia, 2004). Therefore, both marked and unmarked text can be demanding on the early learner.

Arabic Syntax

The Arabic sentence is divided into two types: nominal and verbal. The nominal sentence is the sentence that starts with a noun or a pronoun. It consists of /mubtædæʔ/ مبتدأ "a topic", and /x^bər/ خبر "a predicate". An example will be /ʔər^ʤulu ħɑdˤirun" الرجل حاضر", "The man (is) present". The verbal sentence consists of a verb and a subject (VS) (Ne'ma, 1973). The nominal sentence in Arabic is tenseless; this is why it is sometimes challenging sometimes for Arabic learners of English to construct a correct English sentence without leaving out the verb.

Inflected versus uninflected

Inflecting refers to the change that happens to the final letter of the word due to intervening factors to show the grammatical meaning. "Uninflecting" means that the final letter of the word remains unchanged. It either ends with Sokoon (no vowel ending) or with one unchanged short vowel. Arabic words can either be inflected or uninflected; they cannot have both qualities at the same time. Inflection is show by the three diacritics Fat'ha, Kasrah and Dhammah, as in /kitæbun/ /kitæbin/ /kitabən/ كتابا كتاب كتاب. This is a feature of the first Semitic language, the mother language of the Arabic language. Nouns in Arabic are originally inflected and articles are originally uninflected. In verbs, inflection is secondary to show different conjugations of the verb with first second and third person, and to show tenses as well.

The diacritics that show inflection are Dhammah, Fat'hah, Kasrah, and Sokoon (Khalaf, 1994). There are two ways of showing inflections, using the four diacritics and the letters ن ، ي ، و ، ا. This way of inflection is related to verbs and nouns. Examples of nouns are /ʤæʔəlæʕibu:n/ جاء اللاعبون and /r^ʔytulæʕibi:n/ رأيت اللاعبين. In the first example, the word /læʕibu:n/ لاعبون has و (as a subject) since it is masculine plural, while in the second sentence (as an object) it has /i:/ ي. An example from verbs will be /ætˤulæbu yəʤtəhidu:n/ الطلاب يجتهدون and / ætˤulæbu ləm yuhmilu/ الطلاب لم يهملوا. In the first example the verb has the letter ن while in the second it does not. (Eissa, and Almekky, 2010)

Arabic Morphology

There are three types of Arabic morphemes. The first are "prefixes" as in /ækələ/ /yəʔkulu/ "**يأكل** أكل" the prefix /yə/ "**يـ**" indicates that the verb is in the present third-person conjugation. The second type is "infixes" as in /iftəʕələ/ "**افتعل**" the infix is /tə/ "**ت**". The third is "suffixes" as in /kutubunæ/ "**كتبنا**", the suffix /næ/ "**نا**" refers to the possessive adjective "our", and therefore the word means "our books". Some forms of nouns are formed by adding affixes to the word. For example, the feminine noun is formed by adding one of these suffixes to the word:/ælifun məqsˤu:r^h/ /ælifun məmdu:dəh/ /tæʔun mutəħərikəh/ (ا) ألف ممدودة – (ى) ألف مقصورة – (ة) تاء متحركة. Examples of the three types are: /ælmuʤtəhidəh/ /ləylæ/ /ælʕəmyæʔ/ المجتهدة ، ليلى ، العمياء (Algarem and Ameen, 1999). These differences between the English and Arabic language form some difficulty for Arabic learners of English, who find it sometimes challenging to have two words that represent one in Arabic, or add suffixes instead of prefixes to form the present tense.

The verbs in Arabic are divided into /θulæθəy/ ثلاثي (trilateral-rooted) or /rubæʕəy/ رباعي (quadrilateral-rooted). Each of them is either bare (with no affixes or vowels added) or derivational. For each one of these four types, the verb can either have a vowel letter or not. This leads to having eight different types of verbs. Examples of these are: /wəʕədə/ /nəsˤərə/ /ækr^mə/ /æwʕədə/ /dəħr^ʤə/ /tədəħr^ʤə/ /wəswəsə/ /zəlzələ/ /təzəlzələ/ وَعَدَ، نَصَرَ، أَكْرَمَ، أَوْعَدَ، دَحْرَجَ، تَدَحْرَجَ، وَسْوَسَ، زَلْزَلَ، تَزَلْزَلَ (Makram, 1997).

The following section discusses additional issues that cause extra problems for Arabic-English bilingual children when acquiring L1 or L2 literacy. The first problem is the differences between the two orthographies, which may cause some children to confuse when trying to apply L1 rules L2 literacy. The second problem is the effect of the local dialect which prevails in everyday life in the local community. Arabic-English bilingual children then deal with Arabic (L1), local vernacular (Kuwaiti dialect), and English (L2). This problem is referred to as diglossia.

Some additional differences/similarities between Arabic and English

Some other factors may cause more problems for Arabic-English bilingual children when acquiring literacy, particularly in their second language. One of the diffreneces between the two languages, which might be demanding for beginning learners, is that Arabic and English use different letter characters and a different direction of writing. Furthermore, the relationships between letters and sounds differ for the two languages (Mahfoudhi, et al., 2011).

Another problem that confuse bilinguals is that some of the Arabic language phonemes do not exist in the English language: ء/ح/خ/ص/ض/ط/ظ/ع/غ/ق (Haridi and Madkour, 2006) /ʔ/, /ħ/, /x/, /sˤ/, /dˤ/, /tˤ/, /ðˤ/, /ʕ/, /ɣ/, and /q/, while other English phonemes do not exist in the Standard Arabic language: /g/, /p/, /v/, and /ʧ/ (Allaith and Joshi, 2011). In addition, diphthongs and triphthongs do not exist in all forms of Arabic, only in some dialects. This can be one of the factors that create problems for the Arabic learner when learning the English language. On the level of semantics, some words have more than one meaning in the English language, as the word /məktəbəh/ مكتبة which could be translated as 'library' or 'bookshop', and the word 'uncle' in the English language which has two different words in Arabic /ʕəm/ 'عم' and /xɑl/ 'خال'. Another problem is adjectives since in the Arabic language they have to conform to the word in number, gender, and being definite or indefinite, while in the English language they do not (Haridi and Madkour, 2006). Moreover, in Arabic, noun phrases, adjectives come after the noun, while in English they come before.

The letter ه in the Arabic language has an equivalent in the English language 'h', but the letter ه in Arabic can exist in the initial, medial or final position while in English it never exists at the end of a word (Haridi and Madkour, 2006). Other problems are caused by the spelling of words, like using the definite article /æl/ 'ال' since the /l/ sound is not pronounced if the article precedes certain letters (Haridi and Madkour, 2006).

Kuwaiti Dialect

The general characteristics of northern Arabian dialects, which do not appear in the dialects of neighbouring regions, can be summed as follows:

- The letters /q/ /k/ ك ، ق are pronounced as affricates, examples from the Kuwaiti dialect are the word كان, which is pronounced as /ʤæn/ چان and the word /qɑsim/ قاسم which is pronounced as /gæsim/ جاسم

- The glottal letters affect syllable structure. The initial closed syllable CVC changes to CCV when the first consonant is glottal. These glottal consonants are: /ɣ/, /x/. /ʕ/, /ħ/, /h/ ه ، ح ، ع ، خ ، غ. The word /səxlə/ سَخْل (the young goat) for example changes into /sxələ/ سْخَل. This is practiced by the Awazem, Muteir and Oteiba tribes in Kuwait. (In the Kuwaiti Bedouin dialect, the letter /s/ س in this example changes to be pronounced as /sˤ/ ص)

- Some small syllables do not appear to be consistent with the form /fəʕələt/ فَعَلَتْ they rather change to be as in /fəʕilət/ فْعِلَتْ. The Awazem, for example, say /ðˤribət/ ظْرِبَتْ instead of /dˤ^r^bət/ ضَرَبَتْ

- The singular masculine imperatives that end with the semi-vowel /y/ ي tend to lose this terminal vowel. So instead of saying /imʃi:/ إمشي, the Awazem, Moteiry, Oteibi, and Dosary tribes might say /imʃ/ إمش.

- The letter /ʤ/ ج is pronounced as the semi-vowel /y/ ي. Examples will be the words /wəʤh/ وجه which is pronounced as /wəyh/ ويه and the word /ʕəʤu:z/ عجوز which pronounced as /ʕəyu:z/ عيوز.

- When the past form of the verb is similar to the pattern in /fəʕələ/ فَعَل and the first and second letters are glottal, or when the middle letter is /l/, /n/, /r/ ل، ن ، ر , the pattern changes to /fiʕəl/ فِعَلْ as in /kitəb/ كِتَبْ or to the pattern /fuʕəl/ فُعَلْ as in /mutˤər/ مُطَرْ.

- The pattern of the verbs that start with the letter /æ/ أ is similar to verbs that end with vowel terminals such /kələ/ (ى) كل instead of /ækələ/ أكل (Johnstone,1967)

The Kuwaiti dialect is affected by the diversity of the population living and working in Kuwait. There are many loan words from different languages: e.g.; the word /glɑs/ جلاس 'glass' is literally taken from the English language, the word "spare" /spear/ سبير is taken from English, /derwæzəh/ دروازة from Persian meaning /mədxəl bəwæbəh/ مدخل بوابة (entrance), /ʤu:ti:/ جوتي from Urdu meaning /ħiðæʔ/ "shoes حذاء ". The pronunciation of the Standard Arabic words that do exist in the dialect is also affected by different languages. Farsi (Persian), which has adopted the Arabic alphabet with some modifications, has influenced the pronunciation of several Arabic words in the Kuwaiti dialect. For example, the final letter in the word /bəydˤ/ بيض is pronounced near to the Farsi /z/. Therefore, consistent with many dialects, the Kuwaiti dialect is influenced by many factors. It also differs among certain families (intonation and speed of talking), certain social background (urban versus Bedouin areas) and regions (remote areas like Jahra, which is dwelled mainly by Bedouin families, tend to use words from Old Classical Arabic).

The consonants in the Kuwaiti dialect are losing some of the features of eastern Arabian dialects due to formal education. The letter /q/ ق is not pronounced as /ɣ/ غ or /g/ ج, nor the letter /k/ ك is pronounced as the affricate, /ʤ/ چ, or the letter /ʤ/ ج is pronounced as /y/ ي, except in these examples: (a) the words that do not have an equivalent in the standard Arabic as the word /yəryu:r/ يَرْيور , (b) the word has an equivalent in the standard Arabic or the other dialects, but has a specific terminological meaning, such as the word /bərʤəh/ بِرْچه /sˤəhri:ʤ/ (صهريج) (Johnstone,1967)

Diglossia

Another issue that Arabic-English bilinguals face in Kuwait, is the problem of 'diglossia'. Arab children speak 'spoken Arabic', a language that differs in many respects from 'literary Arabic'. Modern Standard Arabic or MSA is formally used for reading, writing and speaking; though the local dialect tends to be used for much of everyday communication. Literary Arabic differs in vocabulary, phonology, grammar and syntax from the dialects that have developed within the different regions of the Arab world. Different dialects are used across the Arabic-speaking countries or even within the same country (Abu-Rabia, 2004).

Bialystok (2001) argues that the formal differences that divide dialects of the same language, such as Arabic are great (Bialystok, 2001). It could be argued then that Modern Standard Arabic (MSA) is taught to children in school in a similar way to a second language (Saiegh-Haddad, 2007), since its learning follows the natural acquisition of the native dialect. Typically, MSA is not used by children until they attend school with the exceptions may be of cartoons and nursery songs or as part of experiences with media/entertainment.

Background of Arabic Teaching in the State of Kuwait

MSA instruction in the state of Kuwait starts at the kindergarten level. It is (like English) mainly auditory at this stage, and depends highly on games and nursery rhymes. Students start studying a course-book at Grade 1 primary. The first book starts with a preliminary stage that lasts for two weeks at the beginning of the school year. This stage prepares the students for the literacy process through simple oral language. In addition, it prepares them for penmanship and the writing process. Listening comprehension is one of the main components of the book. Grade 2books start having more language content, focusing on sentence structure and phonics, in addition to listening comprehension. Grade 3 books start having reading comprehension passages in addition to having a writing booklet, this extends throughout Grades 4 and 5 which end up with covering all language skills, including simple grammar and vocabulary.

Teachers of Arabic in government schools (where the study is conducted), are mainly Arabs: Kuwaitis, Egyptians, Syrians and Jordanians. As with hiring of teachers of English, The Ministry of Education has a strict policy when hiring teachers to teach Arabic, so all teachers must be qualified in teaching Arabic. They must also have an overall grade of "Good" in their undergraduate certificate, and an educational qualification (whether, undergraduate, postgraduate, or both). All teachers undergo a written exam and an interview, to ensure that their level is suitable. The interview is held in Standard Arabic to ensure that the teachers have an acceptable oral level of the language. Teachers who do not demonstrate proper Arabic pronunciation are not hired by the Ministry. Furthermore, all teachers are required to speak in simplified standard Arabic in the classrooms (dialects are not allowed). In addition to this, the Ministry provides regular training courses for teachers, including a mandatory training upon working for the first time. Many activities are also conducted to ensure that teachers are up to date with information and trends in the field, including seminars, workshops, lectures, and conferences. Similar to English teaching, it is important to note that Arabic teachers' linguistic proficiency and its effect on children's literacy are beyond the scope of this study.

Literacy Research on Arabic

In this section, the studies that investigated Arabic literacy (whether as a first or second language) will be discussed. The primary focus of bilingual research will be on studies that compared Arabic and English bilinguals; other studies of different orthographies will be considered as well. Finally, we will discuss the applicability of the SVR to Arabic.

Decoding as a predictor of Arabic Literacy

The relationship between decoding and literacy was studied in Arabic. Some studies on the Arabic language found a connection between phonological decoding and literacy. For example, Smythe et al. (2008) studied the predictors of word-level literacy (reading and spelling) amongst Arabic, Chinese, English, Hungarian and

Portuguese Grade 3 children. For Arabic-children, the single-word reading task presented to children had a set of words that were fully marked (i.e. vowelized). The other tasks included were visual processing, sound discrimination, phonological/working memory tasks, phonological access (Rapid Naming Tasks), phonological awareness (Alliteration and Rhyming Tasks), and phonological decoding (Non-word Reading- vowelized for Arabic children). For both Arabic and English children, the best predictors of both word-level literacy skills (reading and spelling) were phonological decoding and phonological awareness measures. RAN, on the other hand, predicted English word reading only.

Vocabulary as a Predictor of Arabic Literacy

Studies on Arabic found a link between vocabulary and literacy skills. For example, Farran (2010) found out that vocabulary predicted reading comprehension within Arabic and English for bilingual English-Arabic children in Grades 3, 4 and 5. Results argue that the relationship between vocabulary and comprehension was moderated by the role of non-vowelised reading accuracy in favour of the hi-vocabulary group. This suggests that the ability to read non-vowelised words could be affected by vocabulary knowledge to help recognise words in context. Farran, Bingham and Mathews (2012) found that vocabulary predicted Arabic reading comprehension in English-Arabic bilingual children.

Phonological Skills as Predictors of Arabic Literacy

Most studies of learning to read in Arabic have found a link between phonological processing skills and literacy skills in Arabic (e.g. Smythe et al., 2008). In another study, Abu-Rabia, Share and Mansour (2003) studied the role of phonological processing in reading and spelling among Grade 5 reading-disabled students and Grade 3 typically developing students. Their results indicated that, independent of group; phonological skills were the best predictors of reading and spelling. Their results also suggested that both Arabic and Hebrew scripts require more visual processing due to the nature of both orthographies, which entails using diacritics. Similarly, Al Mannai and Everatt (2005) found that for Grades 1–3 Arabic-speaking children in Bahrain phonological skills (decoding and awareness) were the best predictors of variability in reading and spelling. Abu-Rabia and Taha (2004) found that the most prevailing type of spelling among the dyslexics and the reading-level-matched controls was phonetic in nature, and that lexical orthographic knowledge was not sufficient spelling correctly, which suggests relying on phonological skills for good spelling. Abu-Rabia and Taha (2006) also show that for typically developing native Arabic students in Grades 1 through 9 most spelling errors were phonological across all ages (grades). They argue, based on their results, that the phonological stages of spelling in Arabic extend beyond Grade 9 and that students find difficulty in developing from the phonetic stage to a higher orthographic level.

Saiegh-Haddad and Geva (2008) found that for English-Arabic bilingual children in Grades 3, 4, 5, and 6, phonological awareness predicted reading cross-linguistically and that Arabic phonological awareness predicted Arabic word reading. In addition, phonological awareness was only predictor of pseudoword decoding accuracy in both languages. Smythe et al. (2008) also found phonological awareness was a good predictor of word reading and spelling levels for Arabic and English.

In a cross-sectional study, Farran (2010) found that for Grade 3, 4 and 5 English-Arabic bilingual children, phonological skill predicted word reading (both vowelised and non-vowelised Arabic words), pseudoword decoding, and complex word reading fluency within Arabic and English and Arabic complex word reading fluency. Taibah and Haynes (2011) also found that the best within-grade predictor of basic Arabic decoding and fluency skills for Arabic-speaking children from kindergarten through Grade 3was phonological awareness, which accounted for more variance than rapid naming for all measures and grade levels. Rapid increased steadily and was highest in Grade 3. Phonological memory showed almost no relationship to reading performance. Farran et al. (2012) found that phonological awareness predicted both Arabic vowleised and non-vowelised word reading accuracy and pseudoword reading accuracy in English-Arabic bilingual children.

Evidence from research on preschoolers shows similar results. Zayed, Roehrig, Arrastia-Lloyd and Gilgil (2013) found that Arabic preschoolers at risk of dyslexia demonstrated significant deficits in both phonological awareness and working memory as compared to those not at risk for dyslexia. They argue that preschool children at risk for dyslexia have poor phonological awareness skills and working memory deficits in comparison with children who do not have any problems in reading, i.e. phonological awareness skills and working memory are important for developing reading skills.

Evidence of cross-language transfer of phonological awareness between Arabic and other languages exists. For example, Saiegh-Haddad and Geva (2008) found a significant correlation between phonological awareness in English and Arabic in bilingual children in Canada. Farran's study results (2010) indicated that phonological awareness in Arabic was related to phonological awareness in English. Farran at al. (2012) found similar results. Allaith and Joshi (2011) examined the influence of some aspects of the Arabic phonology system on spelling English words in Bahraini Grade 4 Arabic/English bilingual children. Their finding argue that first language phonological awareness affects second language spelling negatively, since some of English phonemes do not exist in Arabic (as discussed earlier in this chapter). This leads to using Arabic phonemes that are near to them which leads to spelling words wrongly. In their study on Arabic/English bilingual children in Cairo, Tahan, Cline and Messaoud-Galusi (2011) reported no significant relationships between language dominance (children who were stronger in English versus children who were stronger in Arabic) and phonological awareness skills which suggests the transfer of phonological processing skills between languages. In an intervention study, Abu-Rabia, Shakkour and Siegel (2013), examined the effects of an intervention program in English on both English and Arabic orthographic knowledge, phonological awareness, morphological awareness, syntax awareness, reading accuracy, and reading comprehension. Both the experimental and control groups were assessed before and after the intervention. Results showed significant improvement in all linguistic and metalinguistic skills in Arabic except for the orthographic knowledge task in the experimental group after the intervention program. Alshaboul, Asassfeh, Alshboul and Alodwan (2014) also found evidence of phonological transfer from Arabic to English in first-grade Jordanian bilingual children aged 6 to 10.

There is similar evidence for the importance of phonological skills for literacy from studies conducted on bilingual children in Kuwait. For example, Elshikh (2012) investigated relationships between Arabic and English basic literacy and language skills in primary school bilingual children (6-9-year-olds) in Kuwait. Children were tested in both Arabic and English listening comprehension, word reading, non-word reading, word spelling, phoneme deletion, object rapid naming, non-word repetition, and non-verbal ability (Raven's Coloured Progressive Matrices). The results showed that phonological skills were related to basic literacy skills in both Arabic and English. They also showed that phonological skills and hence basic literacy skills in the two languages were related. Phoneme deletion correlated with word reading and word spelling in both Arabic and English. Rapid naming correlated with word reading and word spelling in English, but in Arabic, it correlated with spelling only. Non-word repetition was correlated with word reading and non-word reading in Arabic but in English, it was not correlated with either word reading or word spelling. The relationships between phonological skills and literacy skills were larger than the relationships between phonological skills and both listening comprehension and non-verbal ability skills. Similarly, Everatt et al. (2013) found that Arabic word-level reading (word reading accuracy/fluency in context) was predicted by phonological skills. Phonological awareness measures were found to be predictive of reading levels in Grade 3 children. Working memory measures were found to be more predictive of reading levels amongst Grade 4 children when reading non-vowelised text.

Orthographic Skills as Predictors of Arabic Literacy

Orthographic skills have been found to affect Arabic literacy. The fully vowelised version of Arabic is visually more complex, and this might require more orthographic processing. Mohamed, Elbert and Landerl (2011) investigated the development of fluent reading and spelling in the first 3 years of learning Arabic for native Arabic students in Egypt. Their results showed stronger associations between reading and spelling measures for younger grades versus weaker ones later, which is manifest through the development of spelling skills earlier than fluent reading. Based on these findings they argue that reading and spelling processes share the same and that spelling is the pacemaker of the alphabetic phase, and reading comes later (see Frith, 1986). They, therefore, claim that alphabetic skills are important for reading accuracy orthographic strategies are a vital for fluency. These strategies develop earlier in the Arabic orthography due to the exposure to fully vowelised texts which helps fluency later after removing diacritics. Furthermore, their results show relationship between visual and verbal ability and reading suggesting the importance of visuo-spatial processing for the fully vowelised form of Arabic. Tahan et al., (2011) found that visual skills did not differ for Arabic-dominant groups and English-dominant ones and that the groups did better on the English orthographic task than on the Arabic orthographic task. Ibrahim, Eviatar, and Aharon-Peretz (2002) found that, even for adolescents who speak Arabic as first language, processing Arabic letters was slow due to the complexity of Arabic orthography.

Orthographic features like vowelisation have been found to affect reading in Arabic. Abu-Rabia (1999) investigated the effect of vowelisation on reading comprehension of native Arabic/Hebrew bilingual children (aged 12). His results showed that the children performed better in the vowelised text comprehension task. Everatt et al. (2013) also found that accuracy and rate of word reading were influenced by orthographic factors. For example, vowelised text showed higher accuracy levels and faster reading speeds than non- vowelised text in the Arabic cohorts. For Grade 3 Arab children, comprehension levels were higher in vowelised text than non-vowelised text. On the contrary, amongst Grade 4 Arab children, who had more experience of the de-vowelised text, comprehension levels were higher in non-vowelised than vowelised text. In an intervention study, Ibrahim (2013b) found that although phonological skills training of kindergarten children improved in certain phonological awareness skills tested at the end of kindergarten, reading skills tested at the end of the 1st year were not improved. The researcher suggests that the visual characteristics of Arabic orthography and its orthographic complexity result in a specific reading strategy among skilled readers that involves the cerebral hemispheres differently in Arabic than in English.

Morpho-Syntactic Skills as Predictors of Arabic Literacy

There is also evidence on the importance of morpho-syntactic skills, particularly on comprehension level rather than word level. For example, Saiegh-Haddad and Geva (2008) found that Arabic morphological awareness predicted English word reading and that complex word reading fluency was predicted by morphological awareness within both languages. Abu-Rabia (2007) found that morphological skills and spelling were the strongest predictors of reading accuracy and comprehension among Arabic dyslexic and typically readers in Grades 3, 6, 9 and 12. Different results come from

Farran (2010) who found that Arabic morphological awareness did not explain any variance in Arabic reading comprehension beyond the variance explaiened by age, Arabic phonological awareness, and Arabic vocabulary, while English morphological awareness explained small but significant variance in Arabic vowelised word reading accuracy, non-vowelised word reading accuracy, pseudoword decoding, and complex word reading fluency, after controlling for phonological awareness and vocabulary. In their study of English-Arabic bilingual children, Farran et al. (2012) found that morphological skills explained more variance in Arabic complex word reading fluency than they did in Arabic reading comprehension.

In a more recent longitudinal study by Abu Ahmad, Ibrahim and Share (2014) on 194 native Arabic speakers between the final months of kindergarten and the beginning of Grade 2, results showed that word recognition in fully vowelised Arabic was more related to morphological awareness, rather than syntax. On the other hand,, reading comprehension was more related to higher-order thinking skills, like vocabulary, and sentence-level skills. For example, their results show that morpho-syntactic skills explained 16% of variance in reading comprehension after controlling for vocabulary and non-verbal reasoning (which explained 23% of variance).

The previous review of literacy research conducted on Arabic shows that most studies found phonological awareness to be predictive of word reading and that phonological skills transfer from Arabic to the second language. RAN and phonological memory, similar to research conducted on English show contradicting results. Unlike English, orthographic skills in Arabic seem to affect literacy more. Both vocabulary and morpho-syntactic awareness seem to affect text level in Arabic, though results from research on morphological awareness give somewhat contradicting results. More research is therefore needed to investigate how these factors contribute to literacy acquisition.

The SVR and Arabic Literacy

There is evidence that the SVR could be applied to Arabic. Everatt et al. (2013) found that measures of linguistic comprehension and word recognition/decoding were both able to predict reading comprehension. Language skills of listening comprehension, vocabulary, and syntactic awareness showed evidence of influencing reading comprehension levels. Phonological processing skills and orthographic awareness influenced reading levels via word identification/letter string decoding—with speeded naming times also predicting word-level variability. However, their results show effects of orthography on reading comprehension, since orthographic knowledge was directly related to reading comprehension from an early grade, independent of word decoding. This finding diverges somewhat from the Simple View Model framework in that orthographic processing may not simply influence reading via word level processes. Other skills that were tested in their study are phonological awareness and working memory. The former was found to be predictive of reading levels in grade 3 children, who are more familiar with reading vowelised texts. Working memory, however, was found to be more predictive of reading levels amongst Grade 4 children when processing non-vowelised text.

Chapter Four: Method of the Study

Design

A longitudinal study was conducted in which the same group of primary school children was tested four times over the course of two school years, from the beginning of Grade 3 to the end of Grade 4. Children transition from the oral phase of studying English (which takes place during Grade 1 through Grade 2) to a more formal phase starting from Grade 3, i.e. reading and writing instruction begins. Furthermore, in Grade 4, students shift to using Arabic unmarked texts, for most of the school subjects (the only exception is Arabic and Religion books). Measures were applied over the four test times to determine relationships between these measures and reading and writing in Arabic and English both concurrently and longitudinally (i.e., relationships between potential predictor measures at one time and future outcome measures of literacy). Figure 4.1 illustrates the skills measured in the study along with the tasks used to measure them. The researcher applied the potential predictor measures initially to Grade 3 children in the first year of the research and then again over the following test times in the study (see Table 4.1). Literacy measures were applied at the end of Grade 3 on the same children, and then again at the start and end of Grade 4; these included measures of reading comprehension and written production.

The underlying skills measured included phonological processing, decoding, vocabulary, syntactic awareness, morphological awareness, orthographic processing skills and visual memory, with all languages measures being assessed in both Arabic and English. Phonological processing was tested on three different levels: (i) phonological awareness (using a sound deletion task); (ii) lexical access (using a rapid object naming task); (iii) phonological decoding (using a non-word repetition task). Decoding skills were measured using a non-word reading task, with different measures being used in the first three test times versus the final test time. Vocabulary was assessed via a receptive vocabulary task and morphological awareness by a morphological segmentation task. Word-chain tasks and real word orthographic discrimination tasks were used to measure orthographic processing.

Measures of literacy focused on reading and writing, again in both languages. Reading was measured in the study via single word reading, text reading to assess accuracy and fluency, and reading comprehension involving sentence completion and passage understanding. Writing was measured via word spelling and text spelling tasks, as well as a composition measure.

Data collection did not exceed three weeks to ensure that no students had more learning opportunity than the rest (which might affect their language or literacy level). It was also performed long enough before school exam period to reduce pressure on the children and teachers and to allow the testing to be undertaken within periods of as much free time as possible.

An overview of the four different test time points follows but see also Table 4.1 as a guide to the measures used at the different points in the study.

The study started with 82 students. Time 1 was between September and October 2011, during the first quarter of the first semester of the academic year 2011/2012. The measures applied were: sound deletion Arabic, sound deletion English , rapid naming Arabic, rapid naming English, non-word repetition Arabic, non-word repetition English, non-word reading Arabic, non-word reading English, visual memory, syntactic awareness Arabic, syntactic awareness English, morphological segmentation Arabic, morphological segmentation English, word chain Arabic, word chain English, orthographic discrimination Arabic, orthographic discrimination English, vocabulary Arabic, vocabulary English, word reading Arabic, word reading English, text reading Arabic, text reading English, word spelling Arabic, and word spelling English.

Time 2 measures were applied during the final quarter of the academic year 2011/2012 (between April and May 2012). During this time the following measures were applied to 79 students: non-word reading Arabic, non-word reading English, syntactic awareness Arabic, word chain Arabic, word chain English, vocabulary Arabic, vocabulary English, word reading Arabic, word reading English, text reading Arabic, text reading English, word spelling Arabic, and word spelling English.

Time 3 occurred between September and October 2012, during the first quarter of the first semester of the 2012/2013 academic year. Measures applied to the 72 remaining students (roughly 10 children had dropped out of the study over school and holiday period – see participants section for further information) were: rapid naming Arabic, rapid naming English, non-word reading Arabic, non-word reading English, syntactic awareness Arabic, syntactic awareness English, morphological segmentation Arabic, morphological segmentation English, word chain Arabic, word chain English, orthographic discrimination Arabic, orthographic discrimination English, vocabulary Arabic, vocabulary English, word reading Arabic, word reading English, text reading Arabic, text reading English, word spelling Arabic, and word spelling English.

The Time 4 measures were applied during the final quarter of the academic year 2012/2013 (between April and May 2013). During this time the following measures were applied to 71 students: sound deletion Arabic, sound deletion English, non-word reading Arabic (task 2), non-word reading English (task 2), word chain Arabic, word chain English, reading comprehension Arabic, reading comprehension English, comprehension fluency Arabic, comprehension fluency English, text spelling Arabic, text spelling English, composition Arabic and composition English.

The study aimed to investigate the influence of basic language skills on literacy acquisition of both Arabic and English languages for young learners in Kuwait. Education in the State of Kuwait is supervised by the Ministry of Education and schools follow a formal curriculum required by the government of Kuwait. In order to investigate typical development among Kuwaiti children, and to allow the study to make use of the requirements of the formal curriculum, the study was conducted on individuals in a mainstream government primary school. The mainstream school in the State of Kuwait was selected because it was known to the researcher and followed the normal Kuwaiti government regarding the teaching of English and Arabic, and because the head of the school agreed to allow the repeated testing over the two years needed to complete the research. As prescribed in the curriculum, the children in this school study Arabic as a first language and English as a foreign language. The language of instruction in the State of Kuwait is Arabic and the teaching of English as a foreign language starts in Grade 1 primary, though its teaching as a written form does not occur until Grade 3. Therefore, the study started by testing Grade 3students and followed these same students through Grade 4 at six-month intervals.

Figure 4.1. Skills and Measures

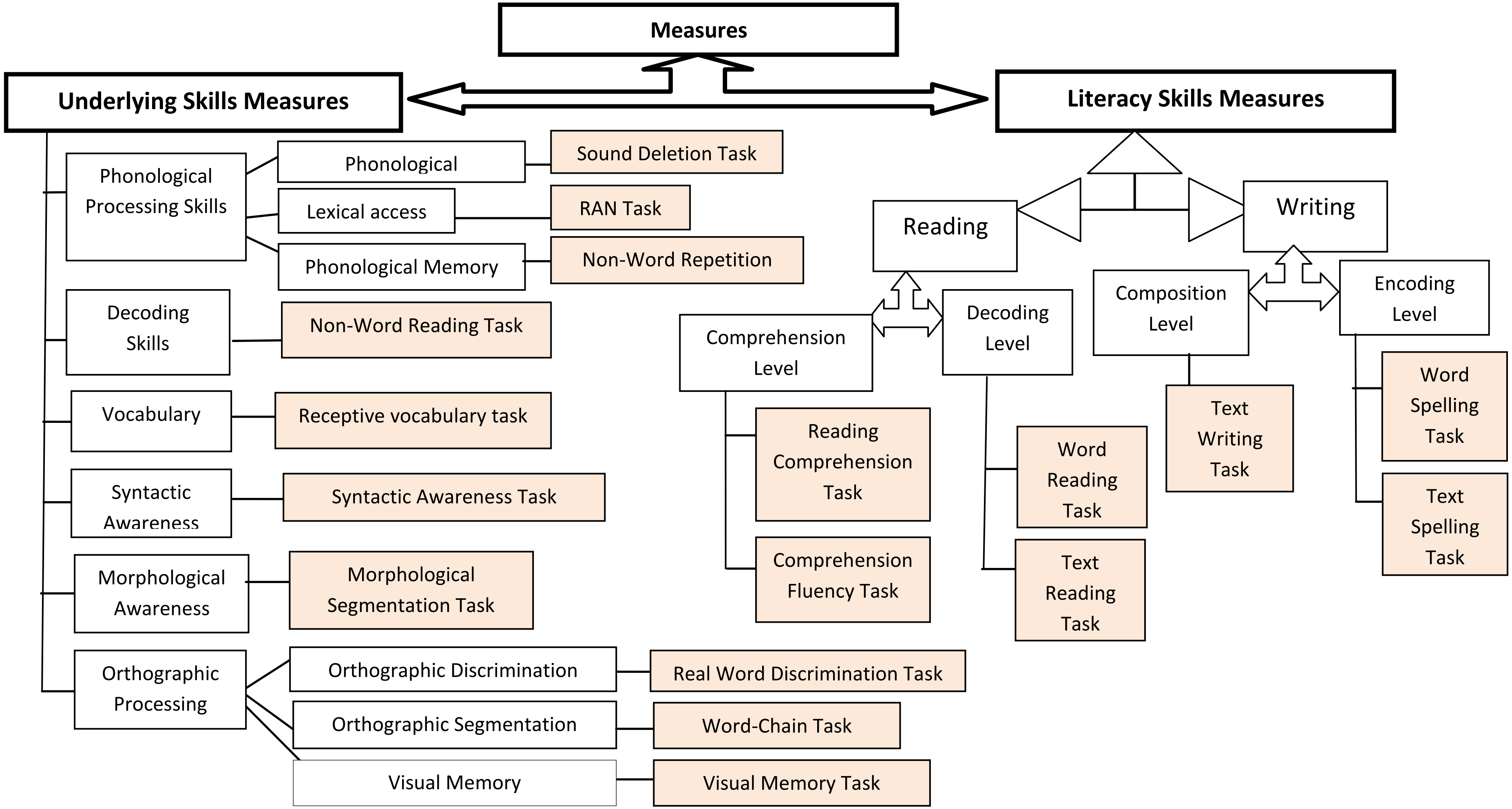


Table 4.1. Measures Administered At the Different Time Points of the Study

<table>
<tr><th></th><th colspan="2"></th><th>Time 1</th><th>Time 2</th><th>Time 3</th><th>Time 4</th></tr>
<tr><td rowspan="10">Underlying Skills</td><td colspan="2" rowspan="3">phonological processing skills</td><td>sound deletion
A & E</td><td></td><td></td><td>sound deletion
A & E</td></tr>
<tr><td>RAN
A & E</td><td></td><td>RAN
A & E</td><td></td></tr>
<tr><td>non-word repetition
A & E</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">decoding skills</td><td>non-word reading
A & E</td><td>non-word reading
A & E</td><td>non-word reading
A & E</td><td>non-word reading
(task2)
A & E</td></tr>
<tr><td colspan="2">vocabulary</td><td>receptive vocabulary
A & E</td><td>receptive vocabulary
A & E</td><td>receptive vocabulary
A & E</td><td></td></tr>
<tr><td colspan="2">syntactic awareness</td><td>syntactic awareness
A & E</td><td></td><td>syntactic awareness
A & E</td><td></td></tr>
<tr><td colspan="2">morphological awareness</td><td>morphological segmentation
A & E</td><td></td><td>morphological segmentation
A & E</td><td></td></tr>
<tr><td colspan="2" rowspan="3">orthographic processing</td><td>word chain
A & E</td><td>word chain
A & E</td><td>word chain
A & E</td><td>word chain
A & E</td></tr>
<tr><td>orthographic discrimination
A & E</td><td></td><td>orthographic discrimination
A & E</td><td></td></tr>
<tr><td>Visual memory</td><td></td><td></td><td></td></tr>
<tr><td rowspan="7">Literacy Skills</td><td rowspan="4">reading</td><td>word reading</td><td>word reading
A & E</td><td>word reading
A & E</td><td>word reading
A & E</td><td></td></tr>
<tr><td>accuracy and fluency</td><td>text reading
A & E</td><td>text reading
A & E</td><td>text reading
A & E</td><td></td></tr>
<tr><td rowspan="2">comprehension</td><td></td><td></td><td></td><td>reading comprehension
A & E</td></tr>
<tr><td></td><td></td><td></td><td>comprehension fluency
A & E</td></tr>
<tr><td rowspan="3">writing</td><td rowspan="2">spelling</td><td>word spelling
A & E</td><td>word spelling
A & E</td><td>word spelling
A & E</td><td></td></tr>
<tr><td></td><td></td><td></td><td>text spelling
A & E</td></tr>
<tr><td>composition</td><td></td><td></td><td></td><td>composition
A & E</td></tr>
</table>

Participants

Schools are single sex in mainstream education in Kuwait. Therefore, initially, the research targeted two mainstream primary schools in Kuwait, one for boys and one for girls. However, shortly after the work had started, the principal of the girls' school withdrew participation in the research, which led to excluding this school from all but initial pilot work. The boys school, however, cooperated with the research throughout the period of testing.

The research took place in an urban area within Kuwait, mainly housing lower middle-class families. This was targeted to ensure a homogenous cohort of participants in terms of socioeconomic status, and thereby avoid large variability in reading and language skills arising from highly varying socioeconomic factors. The research followed normal ethical principles of research project at the University of Canterbury (ethical approval was gained prior to the commencement of data collection), and the Ministry of Education in Kuwait (permissions were granted six months for data collection).

The initial selection of children from school grades was non-targeting: i.e., any child in a year group within the school was included following permission/consent (see Appendix 1 for all consent forms and information sheets). However, children who were repeating a year (those that had failed end of year exams and therefore are not allowed to move to the next grade) were excluded to ensure that the group tested had the same level of second language experience, as was any child with evidence of major learning, psychological or health problems (based on school reports) or who was within the school for a short period of time only.

The study started with 82 male students from Grade 3 at time 1. The mean age of the participants was 96.43 months (ranging from 90.00-104.00) at this initial point in the work (see details in Table 4.2). At time 2, two students withdrew and one left the school so the measures were applied to the remaining 79 students: the mean age of these participants was 102.00 months (range 96.00-110.00). By time 3, which was the beginning of the school year 2012/2013, six students had moved from the school. It is common in similar areas to rent accommodation, therefore, when parents have to move to a new rental accommodation, or in some cases private property, children end up in a new school locality, since schooling system is based on residence areas. This process normally takes place over the summer vacation, therefore, by the beginning of the new school year, there were 73 students. Another child was travelling abroad with his family, leaving 72 students in the cohort at this time of data collection: mean age 108.10 (range 99.00-116.00). At time 4, one student was excluded from the cohort due to his repeated absence from the school (which was probably related to his academic failure) and, according to the social worker, because he had many family problems at home. Hence, by the end of the study, there were 71 students with a mean age of 113.97 (range 105.00-122.00).

Table 4.2. Number and ages of participants at the different test times

	Time 1	**Time 2**	**Time 3**	**Time 4**
Mean age in months	96.43	102.00	108.10	113.97
Range of ages in months	90.00-104.00	96.00-110.00	99.00-116.00	105.00-122.00
Number of participants	82	79	72	71

All participants spoke Arabic as their mother tongue, and all came from Arab countries: Kuwait, Egypt, and Syria. They were all exposed to formal Arabic and English tuition for the first time in the school in which the research was conducted. Both Arabic and English classes occurred on a daily basis, five times a week. Each class lasted for 45 minutes. However, in addition to their formal learning of English, participants were exposed to the English language in the local community, where most restaurants, shops, hotels, hospitals, clubs, etc. hire expats workers who mainly speak English. Furthermore, many of the participants will use the English language to communicate with maids (recruited to look after the children) either at home or school.

Measures

A range of measures was used across the four test times in the study. These are described below. The descriptions include information about the background to their development (including measures in the literature that the current measures were based on), as well as information on, and examples, of the items used in the measures and how these were marked in the current study. The instructions given to the children are also explained below, and examples were used for each measure to ensure understanding. Details of the pilot work, and the findings from these pilot studies, are also presented. Finally, when in the study the measure was used is also detailed – though this information also can be found in Table 1 above. Internal consistency reliability was assessed using Cronbach's alpha coefficients. For tests that were based on those previously standardised, Cronbach’s alpha estimates from the previous work are also reported. Test-retest correlations were used as evidence for reliability when Cronbach’s alphas could not be calculated: i.e., for tests that had only one testing item, as in the time scores for the rapid naming tasks. Reliability estimates ranged from tests having relatively high Cronbach’s alphas (such as the word reading and reading fluency measures), to those showing relatively lower Cronbach’s alphas (such as the visual memory and phonological memory tasks). Evidence for reliability could not be provided for the composition measures given the type of productive task used; however, this sort of writing task is used often in education settings and although a limitation in the present study, it does show correlations with other measures (e.g., spelling), and can be used as the basis of additional research on writing in the future.

Non-Word Reading

In this task, the child is required to read non-words presented on a sheet of paper by the tester. Arabic and English versions were produced based on those in the literature to ensure that the non-words are consistent with sequences of sounds found in each language. The Arabic version of this task was based on a sub-test of a test battery from Centre for CCET, Kuwait (see Taibah, Elbeheri, Aldiyar, Everatt, Mahfoudhi and Haynes, 2011 for the complete measure). The English version was designed by the researcher following the rules of word structure and being consistent with the Arabic version. Some items, however, were derived from Elshikh (2012). These items are *miction, howt, bupper, garken, moop, fraces, catavap, clate, plavel prejend* and *hirth*. The English version Task 2 had some items derived from Elshikh (2012). These items are: *miction, sabotack, rebably, fitosal, zalotipik, catashin* and *misprelture*. The rest of the items were designed by the researcher following the rules of English word structure. There were 20 items in the English version of the measure produced. Some examples are: "vatch" (one syllable) and "chenwits" (two syllables). The words were constructed to include mono-syllabic and multi-syllabic words. Four drill examples preceded each task to ensure that the child fully understood it. The Arabic measure consisted of 25 items preceded by four training examples. Some items from the Arabic measure are: "بَشْخ" /bæʃx/ (one syllable) and "**اسقع**", /isqəʕ/ (two syllables), (see Appendices 12 and 13 for the complete English and Arabic measures).

The child was instructed to read the non-words clearly. The examiner would help the child with example items to ensure that the child understands the task properly. The children's responses were recorded and assessed to determine that they have read the non-word correctly. The number of non-word read correctly was the score for this task. The English measure was piloted on 15 children and the Arabic was piloted on 16 children (see Table 4.3. for Pilot Study results).

Table 4.3 Results of the pilot of the Non-word Reading tasks 1 pilot 1

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic non-word reading Task 1	10.00	4.91	20.00	2.00	99.54
English non-word reading Task 1	5.07	3.04	11.00	1.00	99.37

Based on the pilot results, the number of items in the English measure was increased to 25 items to be consistent with the Arabic measure. The new items added were: *dat, dar*, *pim, zet* and *lunt*. The measure was then piloted on 13 children who later became part of the main cohort of the study. Finally, the new measure was graded in terms of difficulty (see Table 4.4 for pilot 2 results).

Table 4.4 Results of the pilot of the Non-word Reading tasks 1 pilot 2

	Mean	Standard Deviation	Max	Min	Mean Age in Months
English non-word reading Task 1	9.15	5.32	19.00	3.00	98.00

Both measures (Task 1) were used four times in the main study in Time1, Time 2 and Time3. The mean age of children at Time 1 was 96.43 months; this is why the pilot work was done on a group of children around the same age of the expected main study cohort at that point of time. A different version was constructed in Time 4 to avoid familiarity with the task or actually *learning* the items, therefore not measuring actual decoding. The second version of both Arabic and English tests was piloted on 9 children (see Table 4.5 for the results).

Table 4.5 Results of the pilot of the Non-word Reading tasks 2 pilot

	Mean	Standard Deviation	Max	Min	Mean Age (months)
Arabic non-word reading Task 2	15.00	3.00	20.00	9.00	114.61
English non-word reading Task 2	14.00	4.00	20.00	9.00	114.61

Both measures (Task 2) were used in Time 4 of the main study. The mean age of children at Time 4 was 113.97; this is why the pilot work was done on a group of children around the same age of the expected main study cohort at that point of time (see Appendix 2 for, Form B of the Arabic decoding measure and all English decoding measures).

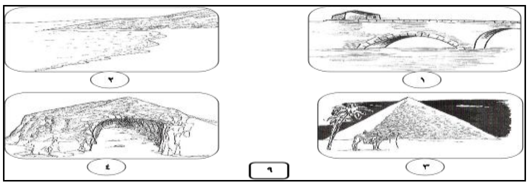
The Cronbach's alpha scores were calculated from the main data obtained in Time 1 for this measure and for the rest of the measures in this chapter. The Cronbach's alpha coefficient for Task 1 Arabic decoding was 0.86, for Task 2 Arabic decoding was .87, for Task 1 English decoding was .86, and for Task 2 English decoding was .88, arguing for a good level of consistency in performance across items each the test.

Vocabulary

Measures of Arabic and English receptive vocabulary were used. These were based on existing tests in the literature. An Arabic measure was built based on an Arabic language version of the Peabody Picture Vocabulary Test (see Abu-Allam and Hadi, 1998, for the complete measure). The English version was constructed by the researcher. Items were derived mainly from the English words that were familiar to the children at this stage, based on the textbooks they study in primary school.

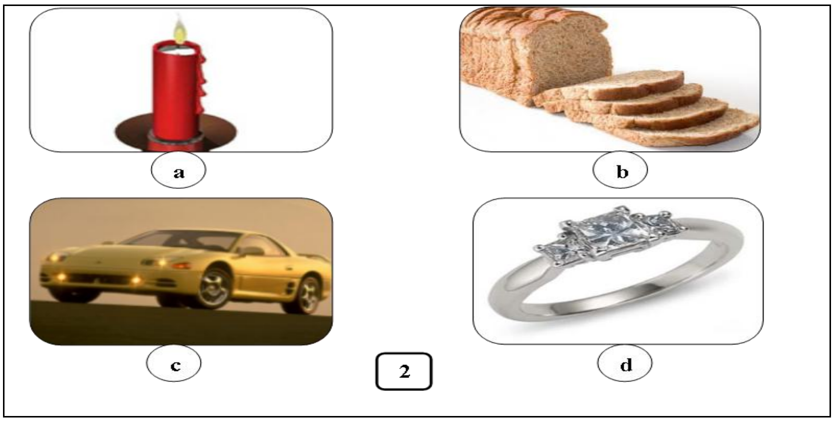
The tasks required the child to point to the picture that represents the word or the phrase spoken by the tester. The examiner said the word orally to the child and they had to choose from four different pictures. The child got a score of one for each correct response. The total of the correct responses was the final score for this test. For both English and Arabic measures, four practice items were given prior to the test items. An example for the Arabic measure is: " The picture of 'a cave' was introduced to child amongst other four different pictures, then the examiner would say to the child: "Point to the picture that represents "مغارة" /məɣɑrəh/ 'a cave', and the child's correct response has to be picture '4' for this example", (see Figure 4.2.).

Figure 4.2. An example from the Arabic Vocabulary Measure



The English vocabulary test was similar to the Arabic version. An example of the English measure is: Point to the picture that shows (or represents) "bread" and the answer here would be picture "b" (See Figure 4.3).

Figure 4.3 An example of the English Vocabulary Measure



The construction method for both and English vocabulary measure was a little bit complicated since both measures had to be changed based on pilot work. When constructing the Arabic measure, the first 35 items of Abu-Allam and Hadi measure were used. These items represent the age category from 4 to 13 years old. Since the children in the main study are aged around 8 to 9 years old, this category was suitable to start with. The Arabic measure was then piloted on 22 children to determine its efficacy in the target population and if appropriate. The initial English test contained 35 items, and each item had five pictures for the child to choose from. The English measure was piloted on 22 children (see Table 6.6. for Pilot 1 results of Arabic and English measures).

Table 4.6 Results of the pilot of the Vocabulary tasks pilot 1

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic vocabulary	29.95	2.71	34.00	24.00	99.45
English vocabulary	24.60	6.88	34	11	99.56

Pilot 1 results (see table 4.6.) show that the Arabic task was quite easy for most of the children, therefore, the first 20 items of the original measure of "Abu-Allam and Hadi" were deleted and more items were added from the original measure to avoid a ceiling effect, namely items 36 to 63. These items represent age categories 12 to 16 years old (See Abu-Allam and Hadi, 1998). The total number of items in the final measure was 43 items (see Appendix 14 for the final measure). The measure was then piloted on 15 children who became part of the cohort in the main study (See Table 4.7. for Pilot 2 results). English task Pilot 1 work showed that many items were beyond the age level of the children e.g. "hedgehog" and "anthemis". All the unsuitable items were excluded from the measure; new items were added, and the number of choices was reduced to four pictures per item, instead of five, to be consistent with the Arabic vocabulary measure (see Appendix 15 for the final measure). The measure was then piloted on 15 children who became part of the main study's cohort (See Table 4.7. for Pilot 2 results).

Table 4.7 Results of the pilot of the Vocabulary tasks pilot 2

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic vocabulary	27.00	7.00	38.00	15.00	99.90
English vocabulary	24.10	7.11	33.00	11.00	99.87

After the abovementioned changes had been made based on pilot work, the final English measure had forty-five items in addition to four training examples, while the Arabic measure had forty-three items in addition to four training items. Both vocabulary measures were used three times in the main study, in Time 1, Time 2, and Time 3. The mean age of children at Time 1 was 96.43; this is why the pilot work was done on a group of children around the same expected age of the main study cohort (see Appendix 3 for the initial and final English vocabulary measures and key answers to the Arabic vocabulary test. It is worth noting that the final vocabulary measure in the appendix was scaled to fit on the page and the original pictures/drawings used with the children were bigger in size). The final vocabulary measures provided good Cronbach's alpha coefficients (.86 for Arabic and .86 for English), arguing for a good level of consistency in performance across items within both measures.

Phonological Awareness

Sound deletion measures were used in both Arabic and English. These were based on measures in the literature and were piloted to ensure their efficacy with the target population. The Arabic sound deletion version of this task was based on a sound deletion sub-test of a test battery from Centre for Childhood Evaluation and Teaching

(CCET), Kuwait (see Taibah et al. 2011, for the full Arabic sound deletion measure). The English version of the test was derived from Al-Rashidi (2010).

Thirty items were used following three example items. Each item comprised of a word in which a sound has to be deleted. The child was required to say the word minus the sound: e.g., "Say CAT without the /k/ sound", the correct response being /æt/, for middle position "silk" without /l/ which will be /sik/, and for final position " cold" without /d/ which will be /col/; Arabic examples would be the word "قوارب" /qəwærib/ after deleting /ق/ /q/ producing the right response /وارب/ /wærib/, "حبس" /ħæbs/, without /ب/ /b/ which will be / حس/ /ħæs/, and "خروج" /xuru:ʤ/ without /ج/ /ʤ/ which will be /خرو/ /xuru:/ (Appendices 6 and 7 present the Arabic and English items used in this study). Each item was presented individually, and the deleted sound was from the initial, medial or last part of the word. Arabic and English measures were consistent in the number of items and shape, i.e. the measures contained equal numbers of items for each type of deletion: each measure had thirty items, ten for initial sound deletion, ten for middle sound deletion, and ten for final sound deletion. The number of words minus the correct sound produced is the measure for this task. The task was explained to the child clearly. The examiner gave the three examples to the child and helped them give the correct response if needed for these three items only. The child then was informed that they had to do the rest themselves. Then, the examiner said the word followed by the phoneme to be deleted**.** The child was required to give the word after deleting this phoneme. Children's responses were audio recorded most of the time for later reference. Both measures were piloted prior to longitudinal data collection. The Arabic version was piloted on 19 children and the English on 15 children. Descriptive analysis of the results of the pilot can be found in Table 5.8.

Table 4.8 Results of the pilot of the Sound deletion tasks

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Sound Deletion	14.89	6.35	23.00	1.00	98.20
English Sound Deletion	14.67	4.72	25.00	6.00	100.30

The English version needed a minor change since the item ‘begin – delete /g/ – be'in’ was difficult and no one got it right in piloting. Therefore it was replaced by ‘brake – delete /r/ – bake’. After piloting, the Arabic and English sound deletion tasks were both measured twice in the study, at time 1 and time 4. The mean age of children at Time 1 was 96.43; this is why the pilot work was done on a group of children around the same age of the expected main study cohort (see Appendix 4 for the initial and final sound deletion measures). Similar to the previous measures, both Arabic and English sound deletion tasks showed a reasonable level of consistency in performance across items within the each test, since they both provided good Cronbach alpha coefficients: .92 for Arabic and .89 for English.

Rapid Automatized Naming (RAN)

Tests of rapid object naming (RAN) in both Arabic and English were used based on those used in the literature. Arabic RAN version of this task was based on a RAN sub-test of a test battery from CCET, Kuwait (see Taibah et al., 2011, for complete Arabic RAN measure). The test was standardised and had a good Cronbach alpha coefficient of .838. The English measure was developed by the researcher to be consistent with the Arabic in the number of items and the way they are displayed, i.e. number of items per row. Both Arabic and English measures were consistent in the number of items and presentation and were both piloted before inclusion in the study. The items of the Arabic version were: وردة – كرة – يد – أرنب – سمكة – بطة – باب مفتاح – بيت – شجرة – قلم – كرسي (these translate in English to *flower, ball, hand, rabbit, fish, duck, door, key, house, tree, pen,* and *chair*), and pronounced / wardəh – kurəh – yəd – ərnæb – səməkəh – bətˤ^h – bæb – miftæħ – bəyt - ʃədʒərəh - q^ləm – kursəy/ respectivley. The items of the English version were: *apple – camel – bag – elephant – banana – bed – camera – bee – carrot – cake – ball – dog* (See Appendix 5 for the English measure).

Objects were represented by pictures consistent with the methods used in past research/testing. Different items were used in the two language versions to ensure familiarity of names of the objects: 12 items were used in the two tasks following piloting. Each object was presented to the child prior to testing to ensure familiarity with the picture and name. The twelve objects were presented in two lines. The student was then presented with an array of items to name. Each item was repeated three times producing an array of 36 items. The test was undertaken individually in a quiet room during the school day. The child was asked to name each object in order as fast as they can, trying to avoid errors. A stopwatch was used to measure the time taking to name all the items. The score for each task is the time taken to name all the items in the array plus a one-second penalty for each naming error.

The Arabic version was piloted on 18 children and the English on 18 children. Descriptive analysis of results of pilot work for these two measures is illustrated in Table 4.9. During piloting, two of the English items were found to cause naming problems (based on higher than expected errors) for most of the children: despite telling the children the pictures names more than once twice prior to speeded naming, many children still named these incorrectly more than once. Therefore, these items were replaced with *orange* and *car*. Both Arabic and English rapid naming was measured twice during the study, at Time 1 and Time 3. The mean age of children at Time 1 was 96.4; this is why the pilot work was done on a group of children around the same age of the expected main study cohort at that time. Cronbach's alpha could not be used as a measure of internal consistency for the English RAN measure, as there is only one score on the RAN task per student. Therefore, since the test was administered twice (once at the beginning of Grade 3, and then once again at the beginning of Grade 4), the correlation between the two scores was used to show evidence of reliability. The correlation between Time 1 and Time 3 was .593 ($p<.001$), which suggests a good level of consistency in scoring of children across the test points. These test-retest correlations indicated that RAN measure tapped a single underlying cognitive-linguistic skill, and that they were measuring something other than chance variability.

Table 4.9 Results of the pilot of the Rapid naming tasks pilot

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Rapid Naming Time in seconds	44.65	8.57	56.00	26.00	99.90
English Rapid Naming Time in seconds	72.63	32.50	151.00	35.00	100.00

Non-Word Repetition

In this task, the child is required to repeat non-words presented orally by the tester. The Arabic version of this task was based on a sub-test of a test battery from CCET, Kuwait (see Taibah et al., 2011, for the complete measure). The test was standardised and has Cronbach alpha of .75. The English version was derived from Al-Rashidi

(2010). The number of non-word repeated correctly was the score for this task. There were 24 items in the English version of the measure produced. Some examples are: *tash* (one syllable), and *thumpuster* (three syllables) (see Appendix10 for the complete measure). As detailed in the previous examples, the words were constructed to include mono-syllabic and multi-syllabic words. Four drill examples preceded each task to ensure that the child fully understood it. The Arabic measure, was constructed in a similar way regarding chosen items, however, it consisted of 20 items preceded by three training examples. Some items from the Arabic measure are: "**بوخْ**" /bu:ʤ/ (one syllable), and "**لاشْتوخَنْسَ**" /læʃtuxəns/ (four syllables), (see Appendix 6 for the complete initial and final measures). The child was instructed to repeat the non-words immediately and clearly. Their responses were recorded and assessed to determine that they have repeated the non-word correctly. Both English and Arabic measures were piloted on 16 children (see Table 4.10. for pilot results).

Table 4.10 Results of the pilot of the Non-word Repetition tasks (pilot 1)

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic non-word repetition	10.31	2.30	14.00	5.00	99.80
English non-word repetition	18.06	2.98	22.00	12.00	99.80

Based on the pilot work (see Table 4.10.), the number of items in the English measure was reduced to 20. The removed items were: *jint*, *tam*, *swad* and *blim*. The new measure was then graded in terms of difficulty. Table 4.11 shows the pilot results of the English measure after changing and excluding the four items. Based on Cronbach alpha coefficient of the English test (.65), it could be argued that the test has a reasonable level of internal consistency, and is measuring something more than random variability.

Table 4.11 Results of the pilot of the final English Non-word Repetition task

	Mean	Standard Deviation	Max	Min	Mean Age in Months
English non-word repetition after deleting 4 items	14.31	2.68	18.00	9.00	99.80

Both measures were used in the main study only once in Time 1. The mean age of children at Time 1 was 96.43; this is why the pilot work was done on a group of children around the same age of the expected main study cohort during this point of time of the study.

Orthographic Discrimination

The Arabic version was based on a sub-test of a test battery from CCET, Kuwait (see Mahfoudhi, Elbeheri, Aldiyar, Taibah, and Everatt, 2012, for the complete measure) and following piloting. The researcher designed the English version to be consistent with the Arabic one. For each language version, 50 items were used and one minute was given to complete as many of these items as possible. Each item comprised two letter strings that are either identical or differ by one letter: two strings using Arabic letters and orthographic rules for the Arabic version and two letter strings using English letters and orthographic rules for the English version – i.e., pairs of items should be orthographically legal in the language of testing. The aim of the test was to measure the child's ability to discriminate these orthographic differences. For example from the Arabic and English tests see Figures 4.4 and 4.5. The first item in the Arabic measure is دجاجة /dədʒædʒəh/ (a chicken) and زجاجة /zudʒædʒəh/ (a bottle). The second item is الحيوان /əlħəyəwæn/ (the animal).

Figure 4.4 Example of Arabic Orthographic Discrimination Measure

X	دجاجة	زجاجة
√	الحيوان	الحيوان

In the Arabic example the first pair is different this why the child needs to put "X", and the second pair is similar, so the child is expected to put "√". In the English example English, the first pair is similar while the second is different.

Figure 4.5 Example of English Orthographic Discrimination Measure

pen	pen	√
take	make	X

Therefore, the child was required to put a tick next to the same pairs and a cross next to the different pairs. A stopwatch was used to control the time taken (i.e., the test will be stopped after 60 seconds). The number of correct responses was the score for the task (See Appendix 7 for the complete English measures). The Arabic version was piloted on 18 children and the English on 19. The results of the pilot study are illustrated in Table 4.12.

Table 4.12 Results of the pilot of the Orthographic Discrimination tasks pilot

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Orthographic Discrimination	13.39	4.72	21.00	7.00	99.75
English Orthographic Discrimination	13.70	5.75	25.00	3.00	99.73

The final measures provided good Cronbach's alpha coefficients (.86 for Arabic and .92 for English), arguing for a good level of consistency in performance across items within both measures. Both measures were used in the main study twice in Time 1 and Time 3. The mean age of children at Time 1 was 96.73; this is why the pilot work was done on a group of children around the expected age of the main study cohort.

Orthographic Segmentation (Word Chains)

Two versions of this test were produced, one of which comprised of Arabic words and the other of English words. The Arabic version was based on a sub-test of a test battery from CCET, Kuwait (see Mahfoudhi et al., 2012, for the complete measure). The format of the English version was designed by the researcher to emulate the Arabic one. Both language versions comprised a sentence with the words jumbled up to make a non-sense sentence. The spaces between each word were then deleted producing a continuous sequence of letters in each language. An example of the Arabic task is: " منـعظيـمحمل " .The student's task was to separate the words using pencil marks: من | عظيم | حمل . These Arabic items are pronounced /min - ʕəðˤi:m – ħəmələ/ and mean 'from', 'great', and 'carried' respectively. Another example of the English task is: "*theboydidlion*". The answer to this example would be: "*the* | *boy* | *did* | *lion*". The score was based on the number of items that were correct after adding marks. In the previous English example, the score would be 4 if the child placed the marks as demonstrated. Misplacing any of the markers in the example will make the score 2, since two items will be wrong in this case. Both Arabic and English versions were piloted on 20 children (See Table 4.13 for Pilot Study results). For the Arabic version, 20 words were used while in the English 23 were used (See Appendix 8 for the complete initial and final English tests).

Table 4.13 Results of the pilot of the Word Chain tasks pilot 1

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Word Chain	9.15	5.62	18.00	2.00	99.39
English Word Chain	8.55	5.20	21.00	1.00	99.27

Based on piloting, two English items were a problem for the children in the cohort. The first is *father*, some of them answered as *fat/her* and others answered as /*father*/, therefore, the item was deleted from the final version of the test. The other item is "*day*" so that both English and Arabic measures will have the same number of items. The word "*day*" had the highest score along with other two items, therefore, it was chosen as being one of the easiest items in the test. The final measure comprised of 20 words as the Arabic one. The measure was then piloted again, (See Table 4.14 for Pilot 2 results).

Table 4.14 Results of the pilot of the Word Chain tasks pilot 2

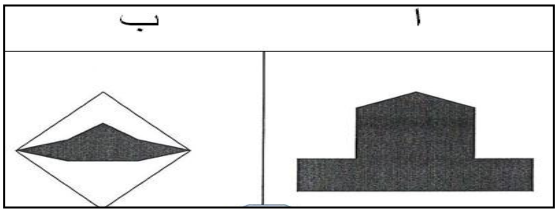
	Mean	Standard Deviation	Max	Min	Mean Age in Months
English Word Chain	7.50	4.53	18.00	1.00	99.27

The final versions ensured that each sequence of words was selected to maintain that the line can be separated in only one way to make a complete set of words. A practice version was used to explain the test requirements and the number of words divided correctly was the measure for the task. The final measures also provided good Cronbach's alpha coefficients (.90 for Arabic and .86 for English), arguing for a good level of consistency in performance across items within both measures. Word chain test was used four times in the study in Time 1, Time 2, Time 3 and Time 4, the results of which will be discussed in details in Chapter 5. The mean age of children at Time 1 was 96.43; this is why the pilot work was done on a group of children around the expected age of the main study cohort at Time1.

Visual Memory

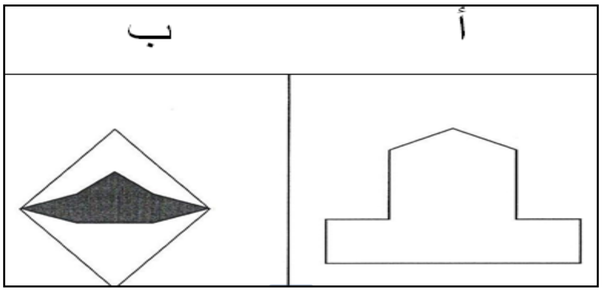
This task comprised combinations of shapes to produce an abstract form (e.g., a combination of squares, circles, stars, etc., some of which were filled and others unfilled to produce a non-meaningful form). The shapes were combined in such a way to make it difficult to recall the forms via the shape names – hence reducing verbal memory effects. In each trial, the child was given several of these forms (two or three in each trial) to study for about 5 to 10 seconds (See Figure 4.6 for an example).

Figure 4.6 Visual Memory Example (Figure 1)



After studying the picture for a few seconds, the forms were removed, and a different sheet of paper was presented. This second page was identical to the first except that one of the forms had been changed in some way, e.g., a filled shape may be unfilled or a shape is large (See Figure 4.7 for an example).

Figure 4.7 Visual Memory Example (Figure 2)



For this example, the changed shape is "أ" since it was filled the first time (See Figure 4.6). The child's task was to identify the form that has changed (See Appendix 9 for the complete Visual Memory Test. Kindly note that the measure in the appendix is scaled to have a small size, and that the original one had each picture on an A4 paper introduced one by one to the child). The number of forms, as well as the complexity of the forms, was increased over the course of the test. The measure had three practice items with two shapes for each sheet, then the five testing items with two shapes as well. Then after that came a practice item, with three shapes per each sheet, followed by fifteen testing items. The test had 20 items, and the number of correctly identified was the score for this task. The test was piloted on 22 children (See Table 4.15 for Pilot Study results).

Table 4.15 Results of the pilot of the Visual Memory tasks pilot

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Visual Memory	14.9	2.01	18	10	99.56

The Cronbach's alpha coefficient for the measure was 0.70 suggesting a reasonable level of reliability. Visual memory test was used only once in Time 1 of the main study. The mean age of children at Time 1 was 96.43; this is why the pilot work was done on a group of children around the expected age of the main study cohort during that time.

Syntactic Awareness

Two comparable Arabic and English measures of syntactic awareness were constructed. Each measure contained 25 items, with each item not exceeding 6 words per sentence. Sentences ranged to covered different syntactic rules suitable for students grade level. These were based on those in the literature. The Arabic version was based on a sub-test of a test battery from CCET, Kuwait (see Mahfoudhi et al., 2012, for the complete Arabic syntactic awareness measure). The English version was based on Elshikh, (2012). Some items were changed to suit the primary stage level. The Arabic version had 25 items in addition to two practice items to ensure understanding of the task. For each item, two sentences were presented, one of which is syntactically correct while the other is wrong: the word order or function use of a word was incorrect in the context of the rest of the sentence. The researcher read both sentences to the student who was required to indicate the grammatically correct sentence. The number of correct choices was the score for this measure. See Figure 4.8 for an example from the Arabic version.

Figure 4.8 An example of Arabic Syntactic Awareness Measure

أطعمَ المحسنُ مسكينين	ب	أطعمَ المحسنُ مسكينان	أ

Part (أ) of the Arabic item is pronounced /ɑtˤʕəməl'muħsinu miski:næn/,and part (ب) is pronounced /ɑtˤʕəməl'muħsinu miski:nəyn/,and both mean 'The philanthropist fed two poor people.' The researcher would read both sentences and ask the child to tick or circle the correct sentence. For the abovementioned example the correct sentence is "ب", (See Appendix 16 for the complete Arabic version). The English version also contained 25 items plus two practice items to ensure understanding of the task.

Similarly, for each item, two sentences were presented, one of which is syntactically correct while the other is wrong: the word order or function use of a word was incorrect in the context of the rest of the sentence. The researcher read both sentences to the student who was required to indicate the grammatically correct sentence. The number of correct choices was the score for this measure. For an example of the English version is, see Figure 4.9.

Figure 4.9. An example from English Syntactic Awareness Measure

a	Sara drinking milk.	b	Sara is drinking milk.

The answer, in this case, is sentence "b", (For the complete English version see Appendix 17). The initial Arabic version contained 35 items plus practice items. It was piloted on 19 children (See Table 4.16 for Pilot study results). Similarly, the initial English measure contained 35 items plus practice items, and it was also piloted on 19 children (See Table 4.16 for Pilot study results).

Table 4.16 Results of the pilot of the Syntactic Awareness tasks pilot 1

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Syntactic Awareness	25.00	5.00	32.00	15.00	99.31
English Syntactic Awareness	24.00	3.90	32.00	19.00	99.31

Based on the pilot work, in both Arabic and English measures, the number of items were reduced to 25 items, and they were graded in terms of difficulty. When reducing the number of items, syntactic variability was taken into consideration, i.e. the goal was for items to test a variety of grammar rules for both Arabic and English. The reduction of items changes the Pilot results (See Table 4.17 for results).

Table 4.17 Results of the pilot of the Final Syntactic Awareness tasks

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Syntactic Awareness	17.00	4.20	23.00	9.00	99.31
English Syntactic Awareness	18.00	4.10	24.00	11.00	99.31

The final measures had good internal consistency. Cronbach alpha coefficients were .76 and .70 for Arabic and English respectively. Time 1 English syntactic awareness correlated with Time 3 measure (.457, $p < .001$), which also suggest consistency in the scores produced by the students. Both syntactic awareness measures were used twice in the main study in Time 1 and Time 3. The mean age of children at Time 1 was 96.43; this is why the pilot work was done on a group of children around the same age of the expected main study cohort at Time 1 (see Appendix 10 for the initial Arabic measure and the initial and final English measures).

Morphological Segmentation

Morphological segmentation tests were constructed in Arabic and English based on measures used in the literature. The Arabic version was based on a sub-test of a test battery from CCET, Kuwait (see Mahfoudhi et al., 2012, for the complete measure). The English versions contained some items derived from Elshikh (2012). These items are: reading, running, beginner, babies, heard, fattest, thinner, studied, wishes, artist, baker, careful, covered, useful and drinks. The researcher added 10 items from words familiar to students at the primary stage based on English books, so the final version had 25 items. The Arabic version of the test contained 25 items. Each item comprised Arabic words that can be decomposed into two morphological units: a base word or root and an affix or pattern, e.g. "الكتاب = كتاب + ال", meaning the + book = the book, and pronounced /əl + kitæb = əlkitæb/. The child was required to segment the word into these morphological units by placing a line with a pencil between the units. The number of items segmented correctly was the measure for this task. The English version of the test contained 25 items. Each item comprised English words that can be decomposed into two morphological units: a base word or root and an affix or pattern, e.g." **cats** could be segmented into **cat/s** ". The child was required to segment the word into these morphological units by placing a line with a pencil between the units. The number of items segmented correctly was the measure for this task. Both the Arabic and English measures were piloted on 21 children. (See Table 4.18 for pilot results).

Table 4.18 Results of the pilot of the Morphological Segmentation tasks pilot

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Morphological Segmentation	13.81	5.89	25.00	4.00	100.00
English Morphological Segmentation	10.38	3.69	17.00	2.00	99.16

The Arabic measure was then reordered in terms of difficulty. However, two items were replaced from the English measure since they caused a problem for almost all the children in the pilot cohort. These items are "*reorder*" which was replaced by "*played*" and "*stranger*" which was replaced by "*smaller*". The measure was then reordered in terms of difficulty. Both of the final measures had good internal consistency. Cronbach alpha coefficients were .87 and .76 for Arabic and English respectively. Both morphological segmentation measures were used twice in the main study in Time 1 and Time 3. The mean age of children at Time 1 was 96.43; this is why the pilot work was done on a group of children around the expected age of the main study cohort (See Appendix 11 for final Arabic measure and the initial and final English measures).

Word Reading Test

The Arabic Test contained 30 words for the Arabic and a similar amount for the English. Words were taken from appropriate grade level materials and piloted prior to formal testing. Arabic words were derived from the most common words list in school for children in Kuwait based on a list produced by Centre for Childhood Evaluation and Training in Kuwait (see: Mahfoudhi, Elbeheri and Haynes, 2009). Textbooks for the primary stage were used for guidance when choosing the items of the tests, particularly for English since there is no available reference for the most common English words for Arabic-English bilingual children in primary school. All words were real words, the meaning of which should be familiar to the child. The student's task was to read the words in the order presented as clearly and accurately as possible. The response produced by the child was recorded by the tester, and the number of correct answers was used as the measure of word reading accuracy. Some examples from the English version are: *sun*, *mosque* and *supermarket*. Some examples from the Arabic version are: عن /ʕən/ meaning 'about' , الكريمة /əlkəri:məh/ meaning 'generous', and المدحرجات /əlmudəħrəʤæt/ meaning 'rollers' (see Appendix 12 for the complete Arabic and English tests). Arabic test piloted on 17 children and English on 15. Both tests initially had 60 items (See Table 4.19 for results).

Table 4.19 Results of the pilot of the Word Reading tasks pilot 1

	Mean	Standard Deviation	Max	Min	Mean Age (months)
Arabic Word Reading	33.06	12.97	55.00	13.00	99.84
English Word Reading	29.00	13.00	52.00	6.00	100.00

Based on pilot results the number of items in each version was reduced to 30 and then graded in terms of difficulty. The reduction of items changed the pilot results as illustrated in Table 4.20.

Table 4.20 Results of the pilot of the Final Word Reading tasks

	Mean	Standard Deviation	Max	Min	Mean Age (months)
Arabic Word Reading	16.25	6.57	28.00	7.00	99.84
English Word Reading	6.67	3.90	14.00	1.00	100.10

Cronbach alpha coefficient for Arabic word reading was .92 and for English .93, suggesting high internal consistency for both tests. Word reading tests were used in the main study in Time 1, Time 2, and Time 3. The mean age of children at Time 1 was 96.43; this is why the pilot work was done on a group of children around the expected age of the main study cohort in this point of time.

Text Reading Fluency

Again Arabic and English versions were produced based on pilot work and measures used in the literature. The Arabic measure was based on an initial version of Elbeheri, Aldiyar, Taibah, Mahfoudhi and Everatt (2013).The researcher designed the English test based on familiar words from primary stage textbooks. Each test comprised a text in the language of testing, and the child’s task was to read the text aloud and clearly to the tester. The texts were chosen to be appropriate for the level of the children based the grade readers used in the curriculum. The tester noted each reading error to produce a measure of accuracy and the time taken to read the text to allow a measure of fluency to be derived. These scores were similar to those produced in the Word Reading tests, but provided measures of word reading in context – reading in context may be different from isolated work reading, particularly for the developing Arabic reader in texts where diacritic marks are not used (see Elbeheri, Everatt, Reid and Al Mannai, 2006). Two tests were piloted for each version Arabic Text 1, which had 22 words (piloted on 18 children), and Text 2, which had 52 words (piloted on 17 children) and English Text, which had 46 words (piloted on 15 children) and Text 2, which had 49 words (piloted on 14 children) (See Appendix 13 for English and Arabic measures).

Table 4.21 Results of the pilot of the Arabic and English Text Reading tasks pilot 1 (Task 1)

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Text 1 Reading Accuracy	11.44	5.40	22.00	3.00	99.53
Arabic Text1 Reading Time (in seconds)	79.22	57.31	248.00	21.00	99.53
English Text 1 Reading Accuracy	30.00	10.84	46.00	5.00	99.34
English Text1 Reading Time (in seconds)	111.60	49.84	190.00	34.00	99.34

Table 4.22 Results of the pilot of the Arabic and English Text Reading tasks pilot 2 (Task 2)

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Text 2 Reading Accuracy	33.24	14.73	51.00	6.00	99.44
Arabic Text2 Reading Time (in seconds)	128.41	72.07	300.00	40.00	99.44
English Text 2 Reading Accuracy	29.71	8.88	46.00	13.00	99.60
English Text2 Reading Time (in seconds)	132.14	63.05	241.00	39.00	99.60

Based on pilot work, Text 2 Arabic was chosen to be applied in the main study. The reason was that Text 1 had a strange word that almost all the children did not know, "كوبا" which is the Arabic name for Cuba. In addition, the text was too short so that some kids finished it in 21 seconds, which would leave limited room for improvement and would make measuring fluency and accuracy progress difficult later on in the study. Text 2 English was chosen for application in the main study. Text 1 had the word "*Mrs*.", which as an abbreviation formed a challenge for all the children and no one knew it. Moreover, it contained three names which made the task harder: "*Eman*, *Ahmed* and *Sami*". Two of the names are Arabic names, which confused many of the children. Cronbach alpha for text reading accuracy (the test used to measure fluency) was .97 for Arabic and .97 for English. Both measures were used three times in the study, in Time 1, Time 2 and Time 3. The mean age of children at Time 1 was 96.43; this is why the pilot work was done on a group of children similar to the expected age of the main study cohort.

Word Spelling Identification

Arabic and English tests were used based on pilot work. The Arabic measure was based on an early version of Aldiyar, Mahfoudhi, Alhattab, Aldardiry and Alodat

(2012). The researcher designed the English measure to be consistent with the Arabic one. Both the English and the Arabic versions of this task comprised 38 sets of words each. The student listens to the tester saying a word in the context of a sentence and in isolation – the sentence context is used to ensure that the child is clear about the word indicated. The word is spoken both before and after the sentence to make clear which word is the target. For example, the examiner would say: *jam – Jam is sweet – jam*. At the same time, the child is presented with a number of alternative letter strings (three for each trial) on paper. One of these letter strings is the target word and the child has to circle this word. The other letter strings diverge from the target either in terms of visual or phonological similarity and can be either familiar words or non-words (See Figure 4.10. for an example).

Figure 4.10 Example of English Spelling Test (Student's Form)

gam – jam - djam

For both measures, the score is the number of target words identified correctly. Similarly, for Arabic, the examiner would say: غَزالٌ - هذا **غزال** صغير يجري –**غَزالٌ** . It means 'gazelle – This is a small gazelle running – gazelle', and pronounced /ɣəzælun – hæðæ ɣəzælun səɣi:run yəʤri: - ɣəzælun/.

Figure 4.11 Example of Arabic Spelling Test (Student's Form)

قَزالٌ غَذالٌ غَزالٌ

The Arabic measure was piloted on 19 children and the English on 25. (See Table 4.23 for Pilot results)

Table 4.23 Results of the pilot of the Word Spelling tasks pilot 1

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Word Spelling	21.58	6.89	33.00	8.00	99.60
English Word Spelling	13.40	4.32	29.00	7.00	96.90

Based on pilot results, a minor change was made to the English measure. The item "*ice-cream*" was visually confusing for most of the children since the hyphen made many children think it was two words; it was, therefore, replaced by the item "*cream*". The measure was then piloted again on 15 children who became part of the main study cohort (See Table 4.24 for Pilots 2 results).

Table 4.24 Results of the pilot of the Word Spelling tasks pilot 2

	Mean	Standard Deviation	Max	Min	Mean Age in Months
English Word Spelling	18.00	4.70	26.00	11.00	97.27

Cronbach alpha of both Arabic and English show high internal consistency of both measures: .82 and .72 for Arabic and English respectively. Both spelling measures were used three times in the main study: in Time 1, Time 2 and Time 3. (See Aldiyar et al., 2012 for the Arabic spelling test and Appendix 14 for the complete English Tests). The mean age of children at Time 1 was 96.43; this is why the pilot work was done on a group of children similar to the expected age of the main study cohort.

Text Spelling

Spelling in context has been considered a useful measure over-and-above isolated word spelling given the need in Arabic to produce items in context (see Elbeheri et al. 2006). Therefore, two versions were used for spelling for both Arabic and English based on pilot work. The Arabic text was derived from an initial measure of Elbeheri et al. (2013) while the English measure was designed by the researcher using familiar words from primary stage textbooks. These tasks were given later at the end of Grade 4in the study. Texts were read out to the children either in Arabic or English and were produced to ensure that they are appropriate for the student's level of ability in the language of testing – based on grade readers. The students were required to write the text on paper making sure that they write clearly and accurately. The number of words spelt correctly was the measure in this task and, therefore, the paper on which the children wrote was collected and marked. The tester read the whole text once to the student then read for dictation allowing enough time between short phrases for the child to write the words. (See Elbeheri et al. 2013, for the complete Arabic measure and Appendix 15 for the complete English measures). The Arabic text had 77 words and was piloted on 15 children while the English measure had 63 words and was piloted on 12 children (See Table 4.25 for pilot results).

Table 4.25 Results of the pilot of the Text Spelling tasks pilot

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Text Spelling	45.67	22.73	72.00	7.00	113.52
English Text Spelling	27.08	14.75	54.00	7.00	115.99

The final measures had good internal consistency. Cronbach's alpha coefficients were .98 and .96 for Arabic and English respectively. This measure was applied in Time 4 only at the ends of the study (See Chapter 5 for detailed results). The mean age of children at Time 1 was 113.97; this is why the pilot work was done on a group of children similar to the expected age of the main study cohort in Time 4.

Reading Comprehension

Measures of reading comprehension in Arabic and English were developed during the work to assess these skills in Grade 4. Again measures were based on pilot work. The Arabic measure used was based on Elbeheri et al. (2013). The English measure was designed by the researcher so that it is consistent with the Arabic ones. Each measure consisted of 5 texts grading in difficulty with 27 question items on all the texts. Each question had 4 choices. These comprised giving the child a passage to read in the language of testing followed by questions about the content of the text: either literal or inferential. The number of questions answered correctly was the measure for these tasks. The Arabic measure had two versions: marked (vowelised) and unmarked (non-vowelised). The marked Arabic test had 5 short passages. The first passage was followed by three questions, the second by four, the third by eight, the fourth by five, and finally the sixth passage was followed by seven questions. The total number of questions was 27. Each question had four different possible answers for the child to choose from. The total number of the correct answers was the score for this test.

An example of the marked measure is:

يَنامُ أَحْمَدُ مُبَكِّراً، وَ يَسْتَيْقِظُ مُبَكِّراً، ثُمَّ يَذْهَبُ مَعَ والِدِهِ إِلى الْمَدْرَسَةِ نَشيطاً مُتَيَقِّظاً.

كَيْفَ يَذْهَبُ أَحْمَدُ إِلى الْمَدْرَسَةِ؟

أ- سَيْراً　　　ب- مُتْعَباً　　　ج- نَشيطاً　　　د- فَرِحاً

The sentence means: 'Ahmed sleeps early and wakes up early, then he goes to school with his father in the morning active and awake'. The question means 'How does Ahmed go to school in the morning?' The answer to this example is "**نشيطاً** " /naʃi:tən/ meaning 'active'. The unmarked Arabic test had 5 short passages. The first passage was followed by two questions, the second by three, the third by five, the fourth by seven, and finally the sixth passage was followed by ten questions. The total number of questions was 27. Each question had four different possible answers for the child to choose from. The total number of the correct answers was the score for this test. An example of the unmarked test is:

قال أحمد: أنا أحب القراءة في مجلات الأطفال.

1- ماذا يحب أحمد؟

أ- اللعب ب- السباحة ج – القراءة د- الرياضة

The sentence means 'Ahmed said: I love to read children's magazines.' The question means 'What does Ahmed love?' The answer to this example is "القراءة" /alqirɑʔəh/ 'reading', (see Elbeheri et al., 2013, for the complete Arabic measures). The English test had 5 short passages. The first passage was followed by two questions, the second by five, the third by six, the fourth by six, and finally the sixth passage was followed by eight questions. The total number of questions was 27. Each question had four different possible answers for the child to choose from. The total number of the correct answers was the score for this test (see Appendix 15 for the English Reading Comprehension test). The following is an example of the English Comprehension test:

Ali said: "I love reading English books at home."

1- What does Ali love?

a- eating *b- reading* *c- playing* *d- swimming*

The correct answers here will be: *a-reading*

The Arabic marked comprehension measure was piloted on 25 children. The unmarked Arabic measure was piloted on 13 children. The English measure was piloted on 12 children (See Table 4.26 for results)

Table 4.26 Results of the pilot of the Reading Comprehension tasks pilot

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Reading Comprehension - Marked	13.72	5.37	22.00	3.00	114.70
Arabic Reading Comprehension - Unmarked	18.77	4.80	26.00	10.00	115.00
English Reading Comprehension	12.92	7.33	24.00	1.00	115.99

Cronbach alpha coefficient was .82 for Arabic Marked-Text Comprehension, .87 for Arabic Non-Marked Text Comprehension, and .84 for English Comprehension. This shows that all comprehension tests show proof of high internal consistency. All comprehension measures were used on once in Time 4 at the end of the study (See Chapter 5 for detailed results). The mean age of children at Time 1 was 113.97; this is why the pilot work was done on a group of children similar to the expected age of the main study cohort in Time 4.

Comprehension Fluency

Both English and Arabic measures were developed to assess comprehension fluency. The Arabic measure used was derived from Elbeheri et al., (2013). The English measure was designed by the researcher so that it is consistent with the Arabic one. Each test had 50 items that comprised of an incomplete sentence with four multiple choices for the child to choose from. The total of the correct answers was the score for this test. The child was given only three minutes to answer as many sentences as they could. An example of English comprehension fluency tests is:

- *I eat breakfast in the……………….*

a- morning *b- evening* *c- afternoon* *d- night*

The correct answer for this example will be *a-morning*.

An example of the Arabic fluency tests is:

أيام الأسبوع.............................

أ-عشرة **ب- سبعة** **ج- ثمانية** **د-خمسة**

The item means 'Days of the week are…….'. The correct answer for this example will be "**سبعة**" /səbʕəh/ meaning 'seven' (see Elbeheri et al., 2013, for the complete Arabic measure and Appendix 17 for the complete English Comprehension Fluency measure)

The Arabic measure was piloted on 15 children and the English on 11 children (See Table 4.27. for Pilot results)

Table 4.27 Results of the pilot of the Reading Comprehension Fluency tasks pilot

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Reading Comprehension Fluency	14.07	9.93	43.00	5.00	116.16
English Reading Comprehension Fluency	11.82	9.18	34.00	2.00	115.17

The Arabic comprehension fluency measures produced a Cronbach alpha coefficient of .95, showing high reliability for the measure indicating evidence for high level of reliability. The English comprehension fluency measure produced a Cronbach alpha coefficient of .70, which suggests a reasonable level of reliability, and also correlated significantly with the English comprehension measure ($r = .464$, $p < .001$), which suggests it is measuring something other than random variability. Both Arabic and English tests were applied only once in Time 4. The mean age of children at Time 4 was 113.97; this is why the pilot work was done on a group of children similar to the expected age of the main study cohort during that time.

Composition Coherence

Two versions were made of this measure, English and Arabic. They both had a picture to write five sentences, at least, related to the content of the picture. Both tests were derived from a diagnostic battery of tests prepared by Aldeyar et al. (2012). Children were given enough time (not less than 5 minutes) to look at the picture and describe it. The pictures were coloured and directions were clearly given before the task (See Appendix 18 for both Arabic and English Composition measures). The composition was given a grade out of ten for overall coherence; that is how much the sentences are related to the picture. The Arabic test was piloted on 15 studnets and the English on 11 (See Tables 4.28 for Pilot results).

Table 4.28 Results of the pilot of the Composition tasks pilot

	Mean	Standard Deviation	Max	Min	Mean Age in Months
Arabic Composition coherence	5.27	2.37	10.00	1.00	114.37
English Composition coherence	4.64	3.61	10.00	1.00	114.81

Both Arabic and English tests were applied only once in Time 4 and produced only one score per student. Therefore, reliability cannot be provided for this measure at this point. The mean age of children at Time 4 was 113.97; this is why the pilot work was done on a group of children similar to the expected age of the main study cohort during that time.

Procedure

Students were individually tested during the school day in a quiet room allocated by the school administration or in the school library when they had no classes or visitors. Most oral responses were recorded on audiotape for later reference to reduce mistakes. The researcher administered most the measures herself. Some of the reading tasks (the ones with no time limits; particularly isolated real word reading) were done by assistants who were school teachers and were well-trained by the researcher on how to administered the task and instruct students. They were asked to record the student's reading for later reference by the researcher.

Prior to testing at Time 1, the teacher(s) introduced the researcher to the children to ensure that they were familiar and comfortable with her. Administration of the measures was organized so that there was a minimum one task at a time (unless a child refuses to complete a task for any reason) and maximum four tasks, to avoid performance being affected if they got bored, tired or uncomfortable. Multiple administrations also ensured that the children were not confused between the English and Arabic tasks.

Chapter Five: Results

In this chapter, the concurrent effects of Time 1, Time 2 and Time 3 variables on word identification (word reading), word attack (decoding), and text reading fluency are investigated. The results are shown for each of the study times: Time 1, Time 2 and Time3. Time 4 results investigate concurrent effects of the variables in Time 4 on reading comprehension, comprehension fluency, text spelling, and composition coherence. For each time, descriptive data statistics (means, standard deviations, minimum-maximum scores, and the maximum possible scores for the measures in the study) are shown. Then within-time correlations of the variables are shown, followed by regression analysis to investigate predictors of literacy measures in that time. Finally, a path analysis is conducted to investigate relations between these predictors and the outcome measure.

Time 1

Table 5.1 demonstrates the descriptive data analysis of Time 1 for Arabic and English measures and the non-language measure. The table shows the means, standard deviations (in round brackets), minimum-maximum scores, and maximum possible scores (in square brackets). Tables 5.2 and 5.3 demonstrate correlations within Time 1 for Arabic and English measures (respectively) and the non-language measures. Table 5.4 demonstrates correlations across languages in Time 1.

Table 5.1. Descriptive data analysis at Time 1, Means, with standard deviations in round brackets, minimum-maximum scores, and the maximum possible scores in square brackets, for the measures in the Study for Arabic and English measures and the non-language measure

	Arabic	**English**
Word Reading	14.61 (7.72) 0-29 [30]	9.49 (7.27) 0-28 [30]
Text Reading Fluency	.33 (.29) 0-1.46	.19 (.2) 0-1.07
Word Spelling	21.65 (6.63) 10-34 [38]	16.82 (5.59) 6-35 [38]
Non-word Reading	8.04 (5.39) 0-21 [25]	5.85 (4.80) 0-19 [25]
Vocabulary	25.10 (7.78) 8-40 [43]	24.22 (7.83) 7-43 [45]
Sound Deletion	14.87 (7.62) 0-28 [30]	12.61 (6.79) 0-27 [30]
Rapid Naming Time	51.65 (11.13) 28-76	77.38 (30.06) 30-187
Non-word Repetition	12.45 (3.64) 5-20 [20]	13.43 (3.21) 3-20 [20]
Orthographic Discrimination	14.33 (4.89) 5-27 [50]	16.09 (6.08) 4-40 [50]
Word Chain	4.63 (4.78) 0-20 [20]	4.16 (3.97) 0-18 [20]
Visual Memory	12.02 (3.54) 0-19	
Syntactic Awareness	17.44 (4.17) 5-24 [25]	15.24 (4.05) 3-23 [25]
Morphological Segmentation	14.41 (5.55) 3-25 [25]	8.51 (4.03) 0-19 [25]

Table 5.2 Correlations within Time 1 for Arabic measures and the non-language measures.

Arabic	word reading	text reading fluency	word spelling	Non-word Reading	Vocabulary	Sound Deletion	Rapid Naming	Non-word Repetition	Orthographic Discrimination	word chain	visual memory	Syntactic Awareness
word reading												
text reading fluency	.743**											
word spelling	.771**	.704**										
Non-word Reading	.733**	.559**	.654**									
Vocabulary	.307**	.368**	.309**	.195								
Sound Deletion	.645**	.563**	.585**	.673**	.272*							
Rapid Naming	- .331**	-.427**	- .357**	- .117	- .215	- .286**						
Non-word Repetition	.202	.238*	.172	.118	.285**	.230*	- .154					
Orthographic Discrimination	.249*	.329**	.177	.114	.067	.146	- .127	- .133				
Word Chain	.446**	.467**	.478**	.398**	.092	.400**	- .107	- .002	.112			
Visual Memory	.467**	.271*	.322**	.300**	.220**	.385**	- .233**	.192	.144	.197		
Syntactic Awareness	.548**	.460**	.459**	.434**	.455**	.438**	- .297**	.200	- .034	.146	.443**	
Morphological Segmentation	.582**	.469**	.505**	.547**	.381**	.508**	- .322**	.238*	.028	.358**	.477**	.464**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Table 5.3 Correlations within Time 1 for English measures and the non-language measures.

English	word reading	text reading fluency	word spelling	Non-word Reading	Vocabulary	Sound Deletion	Rapid Naming	Non-word Repetition	Orthographic Discrimination	word chain	visual Memory	Syntactic Awareness
word reading												
text reading fluency	.763**											
word spelling	.630**	.669**										
Non-word Reading	.795**	.633**	.537**									
Vocabulary	.470**	.465**	.199	.341**								
Sound Deletion	.529**	.415**	.318**	.608**	.104							
Rapid Naming	- .522**	-.443**	- .320**	- .417**	- .525**	- .314**						
Non-word Repetition	.292**	.211	.095	.253*	.163	.133	- .416**					
Orthographic Discrimination	.409**	.471**	.400**	.337**	.204	.286**	- .185	.105				
Word Chain	.605**	.736**	.578**	.610**	.308**	.365**	- .360**	.146	.294**			
Visual Memory	.297**	.081	.209	.250*	.198	.314**	- .197	.175	.092	.131		
Syntactic Awareness	.507**	.475**	.293**	.373**	.555**	.338**	- .567**	.251*	.201	.402**	.292**	
Morphological Segmentation	.499**	.572**	.387**	.420**	.289**	.483**	- .248*	.003	.300**	.496**	.233*	.318**

** Correlation is significant at the 0.01 level
 * Correlation is significant at the 0.05 level

Table 5.4 Correlations across languages in Time 1

English \ Arabic	word reading	text reading fluency	word spelling	Non-word Reading	Vocabulary	Sound Deletion	Rapid Naming	Non-word Repetition	Orthographic Discrimination	word chain	Syntactic Awareness	Morphological Segmentation
word reading	.625**	.612**	.572**	.455**	.101	.465**	- .203	.188	.278**	.398**	.367**	.567**
text reading fluency	.467**	.619**	.435**	.440**	-.009	.364**	-.176	.026	.228*	.396**	.326**	.411**
word spelling	.447**	.504**	.485**	.315**	- .024	.316**	- .195	.018	.310**	.417**	.230*	.306**
Non-word Reading	.672**	.523**	.618**	.605**	.103	.556**	- .171	.209	.170	.438**	.315**	.590**
Vocabulary	.243*	.291**	.163	.188	.158	.059	- .212	.179	.108	.017	.327**	.264*
Sound Deletion	.618**	.505**	.537**	.636**	.159	.780**	- .194	.204	.142	.493**	.315**	.536**
Rapid Naming	-.406**	-.386**	- .292**	- .334**	- .280*	- .363**	.300**	- .304**	- .176	- .286**	- .320**	- .325**
Non-word Repetition	.179	.273*	.109	.078	.222*	.191	- .218*	.378**	.008	.189	.225*	.292**
Orthographic Discrimination	.277	.278*	.162	.223*	- .003	.243*	- .133	.005	.308**	.130	.176	.320**
Word Chain	.403**	.390**	.385**	.345**	- .094	.312**	- .064	.022	.302**	.450**	.116	.309**
Syntactic Awareness	.409**	.388**	.359**	.336**	.201	.266*	- .232*	.216	.018	.275*	.472**	.445**
Morphological Segmentation	.441**	.498**	.369**	.452**	- .007	.397**	- .208	.195	.112	.232*	.303**	.411**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Table 5.2 shows the correlations within Time 1 for Arabic measures and the non-language measures. The table shows that Arabic word reading was correlated with both non-word reading and vocabulary. It was not correlated with all phonological processing measures: it was only correlated with sound deletion and rapid naming. However, it was correlated with all orthographic processing measures. In addition, it was correlated with both syntactic awareness and morphological segmentation. Arabic text reading fluency was correlated with decoding, phonological skills, orthographic skills and to all morpho-syntactic skills. Arabic word spelling was also correlated with both vocabulary and non-word reading, and with both syntactic awareness and morphological segmentation. It was correlated with phonological processing measures and with orthographic processing measures, since it was correlated with both sound deletion and rapid naming, and was also correlated with both word chain and visual memory.

Table 5.3 shows the correlations within Time 1 for English measures and the non-language measures. The table shows that English word reading was correlated with non-word reading and vocabulary, all phonological processing measures, all orthographic processing measures, and syntactic awareness and morphological segmentation. English text reading fluency correlated with English decoding, vocabulary, phonological skills (sound deletion and RAN), orthographic skills (word chain and orthographic discrimination) and morphological segmentation. English word spelling was also correlated with non-word reading, sound deletion, rapid naming orthographic discrimination, word chain, syntactic awareness and morphological segmentation.

Table 5.4 shows correlations across languages in Time1. It is clear from the table that all skills in Arabic (except for vocabulary) were correlated with their counterparts in English. The table also shows that Arabic literacy was correlated with English, decoding, phonological awareness, rapid naming, word chain, syntactic awareness and morphological segmentation. It also shows that English literacy was correlated with Arabic decoding, phonological awareness and word chain.

Throughout this thesis, the tables that show regression results will contain different orders of data entry. The independent variable that is entered first in the equation will always be age to be controlled for, followed by the rest of the variables to be investigated. The variable that is added next will be given a number '1', then the following will be numbered '2', and so on. In almost all of the tables, the order of some of the variables is changed to see how much a certain variable adds if entered after another one. The set of variables numbered '1' will refer to the first order of entry of certain variables, e.g. when decoding was entered before vocabulary, it will be number '1' and vocabulary will be number '2'. Usually, this set will be followed by set 'II' in which the order of entry is reversed, which means variable vocabulary will be entered before variable decoding to see how this changes the results, and normally variable vocabulary will be number '1' since it was entered first this time, and decoding will be number '2'. The following sets will work in the same way in any given table. These unique entry procedures were used to determine any unique contribution of these skills to the dependent variable: e.g., variable decoding versus variable vocabulary. Beta scores in the final regression model were reported in the tables. These scores can be used to determine which measures were contributing to variability explained. Beta scores can be interpreted as partial coefficients and indicate the level of association between the variable and word reading once all other variables in the regression have been controlled (see Table 5.5 for an example).

Regression analyses were performed to investigate variance by each measure in Time1. Furthermore, these regression analyses supported the building of the path models that will be explained later in this chapter, and in Chapter 6. The dependent variables in the regression sets were Arabic word reading, English word reading, Arabic text reading, English text reading, Arabic word spelling and English word spelling. For these regression analyses, two tables demonstrate the steps of each regression set. In each set of analyses (data is shown in two tables that basically contain the same data, but the data was split into two tables since one table was huge to fit), one of the abovementioned dependent variables was entered. The independent variables were decoding skills, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The first table shows the regression analysis done to express variance by decoding, vocabulary, phonological awareness and orthographic processing skills. Another set of analysis was conducted to investigate which variables predicted Arabic decoding and English decoding. In these sets of analyses, word decoding was the dependent variable. The independent variables were vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The first table shows the regression analysis done to express variance by vocabulary, phonological awareness and orthographic processing skills, and morpho-syntactic skills

In the first set of analyses (see Table 5.5 and 5.6), Arabic word reading was the dependent variable. The independent variables were decoding skills, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The final beta scores (see Table 5.5) show that the main predictor was decoding (beta score = .451), followed by syntactic awareness (beta score = .194), then orthographic processing skills (orthographic discrimination beta score = .153, word chain = .149 and visual memory = .116).

<table>
<tr><td colspan="8">Table 5.5 Regression analysis to investigate predictors of Arabic word reading</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>vocabulary</td><td>.094</td><td>.092</td><td>F(1,79)=8.053
P=.006</td><td colspan="2">.012</td></tr>
<tr><td>2</td><td>decoding</td><td>.565</td><td>.471</td><td>F(1,78)=84.547
p=.000</td><td colspan="2">.451</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>decoding</td><td>.537</td><td>.535</td><td colspan="3">F(1,79)=91.449
p=.000</td></tr>
<tr><td>2</td><td>vocabulary</td><td>.565</td><td>.028</td><td colspan="3">F(1,78)=5.017
p=.028</td></tr>
<tr><td rowspan="6">III</td><td rowspan="3">3</td><td rowspan="3">phonological processing</td><td rowspan="3">.630</td><td rowspan="3">.065</td><td rowspan="3">F(3,75)=4.387
p=.007</td><td>sound deletion</td><td>.056</td></tr>
<tr><td>rapid naming</td><td>- .121</td></tr>
<tr><td>non-word repetition</td><td>.063</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">orthographic processing</td><td rowspan="3">.692</td><td rowspan="3">.062</td><td rowspan="3">F(3,72)=4.820
p=.004</td><td>orthographic discrimination</td><td>.153</td></tr>
<tr><td>word chain</td><td>.149</td></tr>
<tr><td>visual memory</td><td>.116</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>orthographic processing</td><td>.658</td><td>.093</td><td colspan="3">F(3,75)=6.806
p=.000</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.692</td><td>.034</td><td colspan="3">F(3,72)=2.629
p=.057</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">5</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.714</td><td rowspan="2">.022</td><td rowspan="2">F(2,70)=2.712
p=.073</td><td>syntactic awareness</td><td>.194</td></tr>
<tr><td>morphological segmentation</td><td>.051</td></tr>
</table>

The data in Table 5.5 also show that, after controlling for age, vocabulary explained 9.2% while decoding explained 47% variance of Arabic word reading. When decoding was entered first, it explained 53.5% of variance while vocabulary explained 2.8%. After controlling for age, decoding and vocabulary, both phonological processing and orthographic processing still add unique variance in word reading. When phonological processing was entered before orthographic processing, it explained 6.5% while the latter explained 6.2%. When the order was reversed, orthographic processing explained 8.3% of unique variability while phonological processing became insignificant. After controlling for the previous variables, morpho-syntactic awareness explained 2.2% of Arabic word reading variability. In Table 7.6 the data show that when controlling for age, decoding, phonological processing and orthographic processing, vocabulary did not add any unique variance while morpho-syntactic awareness added 3% of unique variance. Results from this set of analyses indicate that predictors of Time 1 Arabic word reading are Time 1 decoding, orthographic processing, phonological processing and morpho-syntactic awareness.

Table 5.6 Regression analysis to investigate predictors of Time 1 Arabic word reading

		Variables	R^2	R^2 change	Sig R^2 change
I	1	decoding	.537	.535	F(1,79)=91.449 p= .000
II	2	orthographic processing	.643	.105	F(3,76)=7.462 p=.000
	3	Phonological processing	.687	.044	F(3,73)=3.410 P=.022
III	2	Phonological processing	.622	.084	F(3,76)=5.645 P=.002
	3	orthographic processing	.687	.065	F(3,73)=5.037 P=.003
IV	4	Vocabulary	.692	.006	F(1,72)=1.289 p=.260
	5	Morpho-syntactic awareness	.713	.022	F(2,73)=4.233 p=.018
V	4	Morpho-syntactic awareness	.714	.028	F(2,71)=3.422 P=.038
	5	Vocabulary	.714	.000	F(1,70)=.024 P= .878

In the second set of analyses (see Tables 5.7 and 5.8), English word reading was the dependent variable. The final beta scores show that the main predictor was decoding (beta score = .542), followed by orthographic discrimination (beta score = .117), then syntactic awareness (beta score = .109). The data in Table 5.7 show that vocabulary explained 22.2% while decoding explained 45.7% variance of English word reading. When decoding was entered first, it explained 63.3% of variance while vocabulary explained 4.6%. The table shows that when controlling for age, decoding, and vocabulary, the only variable to add unique variance was orthographic processing which added 4% of variance. In Table 5.8 the data show that when controlling for age, and orthographic processing; vocabulary added 3% of unique variance while morpho-syntactic processing added 4%. When either morpho-syntactic processing or vocabulary was entered last, neither of them added any unique variance. Results from this set of analyses indicate that predictors of English word reading are mainly decoding and orthographic processing. Morpho-syntactic Processing and Vocabulary might also predict English Word Reading.

Table 5.7 Regression analysis to investigate predictors of Time 1 English word reading

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	vocabulary	.222	.222	F(1,79)=22.518 p=.000	.090	
	2	decoding	.679	.457	F(1,78)=111.112 p=.000	.542	
II	1	decoding	.633	.633	F(1,79)=136.452 p=.000		
	2	vocabulary	.679	.046	F(1,78)=11.107 p=.001		
III	3	phonological processing	.701	.022	F(3,75)=1.813 p=.152	sound deletion	- .003
						rapid naming	- .091
						non-word repetition	.034
	4	orthographic processing	.731	.030	F(3,72)=2.658 p=.055	orthographic discrimination	.117
						word chain	.078
						visual memory	.055
IV	3	orthographic processing	.717	.038	F(3,75)=3.311 p=.025		
	4	phonological processing	.730	.013	F(2,73)=1.807 p=.171		
	5	Morpho-syntactic awareness	.742	.011	F(2,70)=1.509 p=.228	syntactic awareness	.109
						morphological segmentation	.092

Table 5.8 Regression analysis to investigate predictors of Time 1 English word reading

		Variables	R^2	R^2 change	Sig R^2 change
1		decoding	.633	.633	F(1,79)=136.452 p=.000
2		orthographic processing	.687	.054	F(3,76)=4.329 p=.007
I	3	Vocabulary	.717	.030	F(1,75)=7.867 p=.006
	4	Morpho-syntactic awareness	.735	.018	F(2,73)=2.505 p=.089
II	3	Morpho-syntactic awareness	.726	.039	F(2,74)=2.381 p=.007
	4	Vocabulary	.735	.009	F(1,73)=2.281 p=.127

In the third set of analyses (see Tables 5.9 and 5.10), Arabic Text Reading Fluency was the dependent variable. The independent variables were Arabic Word Reading, Decoding, Phonological Processing, Orthographic Processing and Morpho-syntactic Awareness. The data in Table 5.9 show that when controlling for age and word reading, decoding did not explain any unique variance of Arabic Text Reading Fluency while vocabulary explained only 3%.When controlling for the previous variables, phonological awareness explained 4% while orthographic processing explained 10.5%. When the order was reversed, orthographic processing explained 7% of unique variability. When phonological awareness was entered after orthographic processing the former explained 5% while the latter explained 5% of unique variance. When controlling for all the previous variables, morpho-syntactic awareness explained was insignificant. In Table 5.10 the data show that when controlling for age orthographic processing and phonological awareness, vocabulary did not add unique variance. The table also shows that (after controlling for age and word reading) both orthographic processing and phonological awareness added about 5% of unique variance when either of them was entered first and the other added about 6% when entered last. Results from this set of analyses indicate that the main predictors of Arabic Text Reading Fluency are word reading orthographic processing and phonological processing.

In the fourth set of analyses (see Tables 5.11 and 5.12), English Text Reading Fluency was the dependent variable. The final beta scores show that the main predictors were word chain (beta score = .398), orthographic discrimination (beta score = .197), decoding (beta score = .179), morphological segmentation (beta score = .164), vocabulary (beta score= .153), and visual memory (beta score= .101). The data in Table 5.11 show that when controlling for both age and word reading; the only variable to add variance was orthographic processing which added 15 % of unique variance of English Text Reading Fluency. Table 5.12 shows that when controlling for age, word reading and orthographic processing; morpho-syntactic awareness did not add unique variance. Results from this set of analyses indicate that the main predictors of English Text Reading Fluency are word reading and orthographic awareness.

In the fifth set of analyses (see Tables 5.13 and 5.14), Arabic Word Spelling was the dependent variable. The data in Table 5.13 show that vocabulary explained 8.8% while decoding explained 36.6% variance of Arabic word spelling. When decoding was entered first, it explained 42.3% of variance while vocabulary explained 3%. When controlling for age, decoding and vocabulary, phonological awareness explained 7.2% of unique variance and orthographic processing explained 7% as well.

Table 5.9 Regression analysis to investigate predictors of Time 1 Arabic Text Reading Fluency

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	word reading	.556	.555	F(1,79)=98.785 p=.000	.430	
	2	decoding	.556	.000	F(1,78)=.085 p=.771	.063	
	3	vocabulary	.581	.025	F(1,77)=4.592 p=.035	.109	
II	4	phonological awareness	.622	.041	F(3,74)=2.665 p=.054	sound deletion	.042
						rapid naming	-.193
						non-word repetition	.111
	5	orthographic processing	.688	.066	F(3,71)=5.005 p=.003	orthographic discrimination	.194
						word chain	.211
						visual memory	-.149
III	4	orthographic processing	.639	.058	F(3,74)=3.951 p=.011		
	5	phonological awareness	.688	.049	F(3,71)=3.717 p=.015		
IV	6	Morpho-syntactic awareness	.696	.008	F(2,69)=.897 p=.413	syntactic awareness	.122
						morphological segmentation	-.027

Table 5.10 Regression analysis to investigate predictors of Time 1 Arabic Text Reading Fluency					
		Variables	R^2	R^2 change	Sig R^2 change
I	1	word reading	.556	.555	F(1,79)=98.785 p=.000
II	2	orthographic processing	.608	.052	F(3,76)=3.392 p=.022
	3	phonological awareness	.672	.063	F(3,73)=4.673 p=.005
III	2	phonological awareness	.607	.051	F(3,76)=3.301 P=.025
	3	orthographic processing	.672	.064	F(3.73)=4.765 P=.004
IV	4	vocabulary	.687	.015	F(1,72)=3.479 p=.066

Table 5.11 Regression analysis to investigate predictors of Time 1 English Text Reading Fluency						
	Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
1	word reading	.580	.579	F(1,78)= 110.363 p=.000	.398	
2	decoding	.578	.003	F(1,77)=.579 p=.449	-.037	
3	vocabulary	.592	.019	F(1,75)=3.724 p=.057	.117	
4	phonological awareness	.578	.003	F(3,73)=.161 p=.922	sound deletion	.002
					rapid naming	.012
					non-word repetition	.015
5	orthographic processing	.724	.144	F(3,70)= 13.897 p=.000	orthographic discrimination	.150
					word chain	.367
					visual memory	-.121
6	Morpho-syntactic awareness	.728	.010	F(2,68)=1.500 p=.230	syntactic awareness	.049
					morphological segmentation	.127

Table 5.12 Regression analysis to investigate predictors of Time 1 English Text Reading Fluency				
	Variables	R^2	R^2 change	Sig R^2 change
1	word reading	.591	.579	F(1,78)=110.363 p=.000
2	orthographic processing	.741	.150	F(3,75)=14.448 p=.000
3	Morpho-syntactic awareness	.760	.020	F(2,73)=2.990 p=.057

However, when phonological processing was entered before orthographic processing, the latter did not add unique variance. When controlling for all the previous variables morpho-syntactic Awareness did not add any unique variance. In Table 5.14 the data show that when controlling for decoding and phonological processing, orthographic processing is almost insignificant (p=.059) and it explained 5% of Arabic word spelling variability (coming mostly from word chain: Beta= .233) while morpho-syntactic awareness and vocabulary become insignificant. Results from this set of analyses indicate that the main predictors of Arabic word spelling are decoding and phonological awareness.

Table 5.13 Regression analysis to investigate predictors of Time 1 Arabic word Spelling

		Variables	R^2	R^2 change	Sig R^2 change		Final Beta
I	1	vocabulary	.099	.088	F(1,79)=7.722 p=.007		.073
	2	decoding	.465	.366	F(1,78)=53.273 p=.000		.415
II	1	decoding	.434	.423	F(1,79)=58.983 p=.000		
	2	vocabulary	.465	.031	F(1,78)=4.505 p=.037		
III	3	phonological awareness	.537	.072	F(3,75)=3.889 p=.012	sound deletion	.064
						rapid naming	- .196
						non-word repetition	.044
	4	orthographic processing	.582	.045	F(3,72)=2.584 p=.060	orthographic discrimination	.075
						word chain	.233
						visual memory	- .010
I V	3	orthographic processing	.529	.065	F(3,75)=3.431 p=.021		
	4	phonological awareness	.582	.052	F(3,72)=3.012 p=.036		
	5	Morpho-syntactic awareness	.589	.008	F(2,70)=.649 .525	syntactic awareness	.118
						morphological segmentation	.008

In the sixth set of analyses (see Tables 5.15 and 5.16, which contain the same data), English word spelling was the dependent variable. The data in Table 5.15 show that vocabulary did not explain any unique variance after controlling for age, while decoding explained 28% unique variance of English Word Spelling. When controlling for age decoding and vocabulary, neither phonological awareness nor morpho-syntactic awareness explained any unique variance at all while orthographic processing explained 15% of unique variance of English word spelling variability. In Table 5.16 the data show that when controlling for decoding and orthographic processing, morpho-syntactic awareness became insignificant. Results from this set of analyses indicate that the main predictors of Time 1 English Word Spelling are decoding and orthographic processing.

Table 5.14 Regression analysis to investigate predictors of Time 1 Arabic Word Spelling

	Variables	R^2	R^2 change	Sig R^2 change
1	decoding	.434	.423	F(1,79)=58.983 p=.000
2	phonological processing	.526	.092	F(3,76)=4.919 p=.004
3	orthographic processing	.572	.046	F(3,73)=2.595 p=.059
4	Morpho-syntactic awareness	.582	.010	F(1,72)=1.761 p=.189
5	vocabulary	.589	.008	F(2,70)=.649 p=.525

<table>
<tr><th colspan="8">Table 5.15 Regression analysis to investigate predictors of Time 1 English Word Spelling</th></tr>
<tr><th colspan="2"></th><th>Variables</th><th>R^2</th><th>R^2 change</th><th>Sig R^2 change</th><th colspan="2">Final Beta</th></tr>
<tr><td rowspan="2">I</td><td>1</td><td>vocabulary</td><td>.045</td><td>.037</td><td>F(1,79)=3.091
p=.083</td><td colspan="2">- .148</td></tr>
<tr><td>2</td><td>decoding</td><td>.292</td><td>.247</td><td>F(1,78)=27.216
p=.000</td><td colspan="2">.283</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>decoding</td><td>.292</td><td>.284</td><td colspan="3">F(1,79)=31.706
p=.000</td></tr>
<tr><td>2</td><td>vocabulary</td><td>.292</td><td>.000</td><td colspan="3">F(1,78)=.020
p=.889</td></tr>
<tr><td rowspan="6">III</td><td rowspan="3">3</td><td rowspan="3">phonological awareness</td><td rowspan="3">.312</td><td rowspan="3">.020</td><td rowspan="3">F(3,75)=.726
p=.540</td><td>sound deletion</td><td>- .137</td></tr>
<tr><td>rapid naming</td><td>- .151</td></tr>
<tr><td>non-word repetition</td><td>- .078</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">orthographic processing</td><td rowspan="3">.456</td><td rowspan="3">.144</td><td rowspan="3">F(3,72)=6.377
p=.001</td><td>orthographic discrimination</td><td>.211</td></tr>
<tr><td>word chain</td><td>.335</td></tr>
<tr><td>visual memory</td><td>.100</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>orthographic processing</td><td>.439</td><td>.147</td><td colspan="3">F(3,75)=6.558
p=.001</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.456</td><td>.017</td><td colspan="3">F(3,72)=.763
p=.518</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">5</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.462</td><td rowspan="2">.005</td><td rowspan="2">F(2,70)=.348
p=.707</td><td>syntactic awareness</td><td>- .002</td></tr>
<tr><td>morphological segmentation</td><td>.100</td></tr>
</table>

Table 5.16 Regression analysis to investigate predictors of Time 1 English Word Spelling				
	Variables	R^2	R^2 change	Sig R^2 change
1	decoding	.292	.284	F(1,79)=31.706 p=.000
3	orthographic processing	.436	.144	F(3,76)=6.474 p=.001
4	Morpho-syntactic awareness	.439	.003	F(2,74)=.200 p=.819

In the eighth set of analysis, Arabic word decoding was the dependent variable. The data in Table 5.17 show that phonological awareness explained 42% variance of Arabic word decoding while orthographic processing was insignificant. When orthographic processing was entered first it explained 19% of variance while phonological awareness explained 27% variability. Morpho-syntactic awareness explained only 8 % of Arabic word decoding variability. In Table 5.18 orthographic processing was entered as the last step to see if it will add any variability after controlling for both phonological processing and morpho-syntactic awareness, however it turns out to be insignificant. When morpho-syntactic awareness was entered first it explained 34% of variance and phonological awareness 20%.When phonological awareness was entered first, it explained 46% of variance in Arabic word decoding, and morpho-syntactic awareness explained 8%. Results from this set of analyses indicate that the main predictors of Arabic word decoding are mainly phonological processing, in addition to morpho-syntactic awareness.

In the ninth set of analyses (see Tables 5.19 and 5.20), English word decoding was the dependent variable. Table 5.19 shows the regression analysis done to express variance by vocabulary, phonological awareness and orthographic processing skills, and morpho-syntactic skills. The data in Table 5.19 show that when controlling for age and vocabulary, phonological processing adds 36% of unique variance while orthographic processing adds 32%. Morpho-syntactic awareness, however, did not add unique variance after controlling for the previous variables. In Table 5.20, vocabulary was entered as the last step to see if it will add any variability after controlling for age, phonological awareness and orthographic processing, however, it becomes insignificant. Results from this set of analyses indicate that the main predictors of English word decoding are mainly phonological processing and orthographic processing.

<table>
<tr><td colspan="8">Table 5.17 Regression analysis to investigate predictors of Arabic word decoding in Time 1</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td></td><td>1</td><td>vocabulary</td><td>.038</td><td>.036</td><td>F(1,79)=2.990
p=.088</td><td colspan="2">.298</td></tr>
<tr><td rowspan="6">I</td><td rowspan="3">2</td><td rowspan="3">phonological processing</td><td rowspan="3">.461</td><td rowspan="3">.423</td><td rowspan="3">F(3,76)=
19.884
p=.000</td><td>sound deletion</td><td>.000</td></tr>
<tr><td>rapid naming</td><td>.077</td></tr>
<tr><td>non-word repetition</td><td>.723</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">orthographic processing</td><td rowspan="3">.482</td><td rowspan="3">.021</td><td rowspan="3">F(3,73)=.985
p=.405</td><td>orthographic discrimination</td><td>.446</td></tr>
<tr><td>word chain</td><td>.269</td></tr>
<tr><td>visual memory</td><td>.352</td></tr>
<tr><td rowspan="2">II</td><td>2</td><td>orthographic processing</td><td>.225</td><td>.187</td><td colspan="3">F(3,76)= 6.114
p=.001</td></tr>
<tr><td>3</td><td>phonological processing</td><td>.482</td><td>.257</td><td colspan="3">F(3,73)= 12.071
p=.000</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">4</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.565</td><td rowspan="2">.083</td><td rowspan="2">F(2,71)=
6.736
.002</td><td>syntactic awareness</td><td>.054</td></tr>
<tr><td>morphological segmentation</td><td>.006</td></tr>
</table>

<table>
<tr><td colspan="6">Table 5.18 Regression analysis to investigate predictors of Arabic word decoding in Time 1</td></tr>
<tr><td colspan="2">Arabic decoding</td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>Morpho-syntactic awareness</td><td>.342</td><td>.340</td><td>F(2,78)= 20.172
p=.000</td></tr>
<tr><td>2</td><td>phonological processing</td><td>.543</td><td>.201</td><td>F(3,75)=11.035
p=.000</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>phonological processing</td><td>.460</td><td>.458</td><td>F(3, 77)=21.799
p=.000</td></tr>
<tr><td>2</td><td>Morpho-syntactic awareness</td><td>.543</td><td>.083</td><td>F(2, 75)=6.846
p=.002</td></tr>
</table>

Table 5.19 Regression analysis to investigate predictors of English word decoding in Time 1

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
	1	vocabulary	.117	.115	F(1,79)=10.263 p=.002	.181	
I	3	phonological awareness	.471	.354	F(3,76)=16.943 p=.000	sound deletion	.443
						rapid naming	-.051-
						non-word repetition	.115
	4	orthographic processing	.589	.118	F(3,73)= 7.017 p=.000	orthographic discrimination	.057
						word chain	.403
						visual memory	.019
II	3	orthographic processing	.440	.323	F(3,76)= 14.604 p=.000		
	4	phonological awareness	.589	.149	F(3,73)= 8.853 p=.000		
	5	Morpho-syntactic awareness	.597	.008	F(2,71)= .692 p=.504	syntactic awareness	-.121-
						morphological segmentation	-.029-

Table 5.20 Regression analysis to investigate predictors of English word decoding in Time 1

	Variables	R^2	R^2 change	Sig R^2 change
1	phonological awareness	.437	.434	F(3,77)= 19.782 p=.000
2	orthographic processing	.577	.140	F(3,74)= 8.183 p=.000
3	vocabulary	.589	.012	F(1,73)= 2.203 p=.142

Path Analysis

We conducted a simple regression-based path model of the concurrent relations between the observed variables of Time 1 in the prediction of each of the literacy measures. AMOS 21 (see Arbuckle, 2012, Chapter 4, for an explanation of this use of AMOS). The overall fit of the final model was assessed by chi-square, by root mean square error of approximation (RMSEA), and by comparative fit index (CFI). A model was considered fit if chi-square statistic was insignificant, RMSEA $< .08$, and CFI $> .95$ (for more details on how to use these fit indices, see: Fan, Thompson and

Wang, 1999; Hu and Bentler, 1998). In the initial hypothesised model, we allowed all the exogenous variables (independent variables) to covary. We had all possible paths from the exogenous variables to the endogenous (dependent) variables (unless stated differently; in such cases regression results were used to make the decision of which paths to include in the model). To build a simpler model, we used significant paths only. Insignificant paths were deleted one path at a time. Critical Ratios of a path that were greater than 1.96 were considered significant at the 0.05 level (see Gallagher, Ting and Palmer, 2008). The paths that were not significant were deleted, and checking for model fit each time a path is deleted. In this way, we reached a fit model step by step, with as few parameters as possible (see Blunch, 2008 for more details on trimming models). In all the models, age was controlled for having paths from it to the endogenous variables, and covarying it with the other exogenous variables.

The following codes are going to be used in path models: **nonwordreadAT1**, for Arabic non-word reading in Time 1, **nonwordreadAT2**, for Arabic non-word reading in Time 2, **nonwordreadAT3**, for Arabic non-word reading in Time 3, **nonwordreadAT4**, for Arabic non-word reading in Time 4, **vocabAT1** for Arabic vocabulary in Time 1, **vocabAT2** for Arabic vocabulary in Time 2, **vocabAT3** for Arabic vocabulary in Time 3, **sounddelAT1** for Arabic sound deletion in Time 1, **sounddelAT4** for Arabic sound deletion in Time 4, **nonwordrepAT1** Arabic for non-word repetition in Time 1, **rapidnametimeAT1** for Arabic RAN in Time 1, **rapidnametimeAT3** for Arabic RAN in Time 3, **orthodisAT1** for Arabic orthographic discrimination in Time 1, **orthodisAT3** for Arabic orthographic discrimination in Time 3, **wordchainAT1** for Arabic word chain in Time 1, **wordchainAT2** for Arabic word chain in Time 2, **wordchainAT3** for Arabic word chain in Time 3, **visualmemoT1** for visual memory task, which was applied in Time 1 only, **morphosegAT1** for morphological segmentation in Time 1, **morphosegAT3** for morphological segmentation in Time 3, **syntacawareAT1** for Arabic syntactic awareness in Time 1, **syntacawareAT3** for Arabic syntactic awareness in Time 3, **wordreadAT1** for Arabic real words in Time 1, **wordreadAT2** for Arabic real words in Time 2, **wordreadAT3** for Arabic real words in Time 3,**textreadingfluAT1** for Arabic text reading fluency in Time 1, **textreadingfluAT2** for Arabic text reading fluency in Time 2, **textreadingfluAT3** for Arabic text reading fluency in Time 3,

wordspellAT1 for Arabic word spelling in Time 1, **wordspellAT2** for Arabic word spelling in Time 2, **wordspellAT3** for Arabic word spelling in Time 3, **text compremarkedAT4** for Arabic marked text comprehension in Time 4, **textcomprenonmarkedAT4** for Arabic non-marked text comprehension in Time 4, **compreflueAT4** for Arabic comprehension fluency in Time 4, **textspellAT4** for Arabic text spelling in Time 4, and **compocoherenceA** for Arabic composition in Time 4. The same system will be used for English variables, instead, the letter "A' in each code will be replaced by the letter 'E' to represent the English variable, e.g. **nonwordreadET1**, will stand for **English** non-word reading in Time 1.

Arabic Word Reading Model

The first model included all possible correlations between measures at Time 1, and with all possible paths from Time 1 variables in addition to decoding (that was used as mediator in the model) to Time 1 word reading and, from Time 1 morpho-syntactic skills and phonological skills (based on regression findings) to Time 1 decoding. We allowed the Time 1 (exogenous) variables to covary. Age was controlled for by having paths to word decoding and word reading. Then we allowed it to covary with all the other exogenous variables. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (4) = 4.180, p=.382, CFI=.999, RMSEA=.025, PCLOSE=.472. To build a simpler model, we used variables with significant paths only (See Figure 5.1). The model provided a good fit to the data set: $\chi 2$ (13) = 14.89, p=.340, CFI=.994, RMSEA=.040, PCLOSE=.503. The model confirms the previous findings that phonological processing (sound deletion) and morpho-syntactic processing (morphological segmentation) predict decoding. It also confirms that decoding, orthographic processing (visual memory) and morpho-syntactic processing (syntactic awareness) predict Time 1 word reading. In addition, the model indicates that Time 1 RAN is directly related word reading and that both morphological segmentation and sound deletion are indirectly related to word reading via decoding.

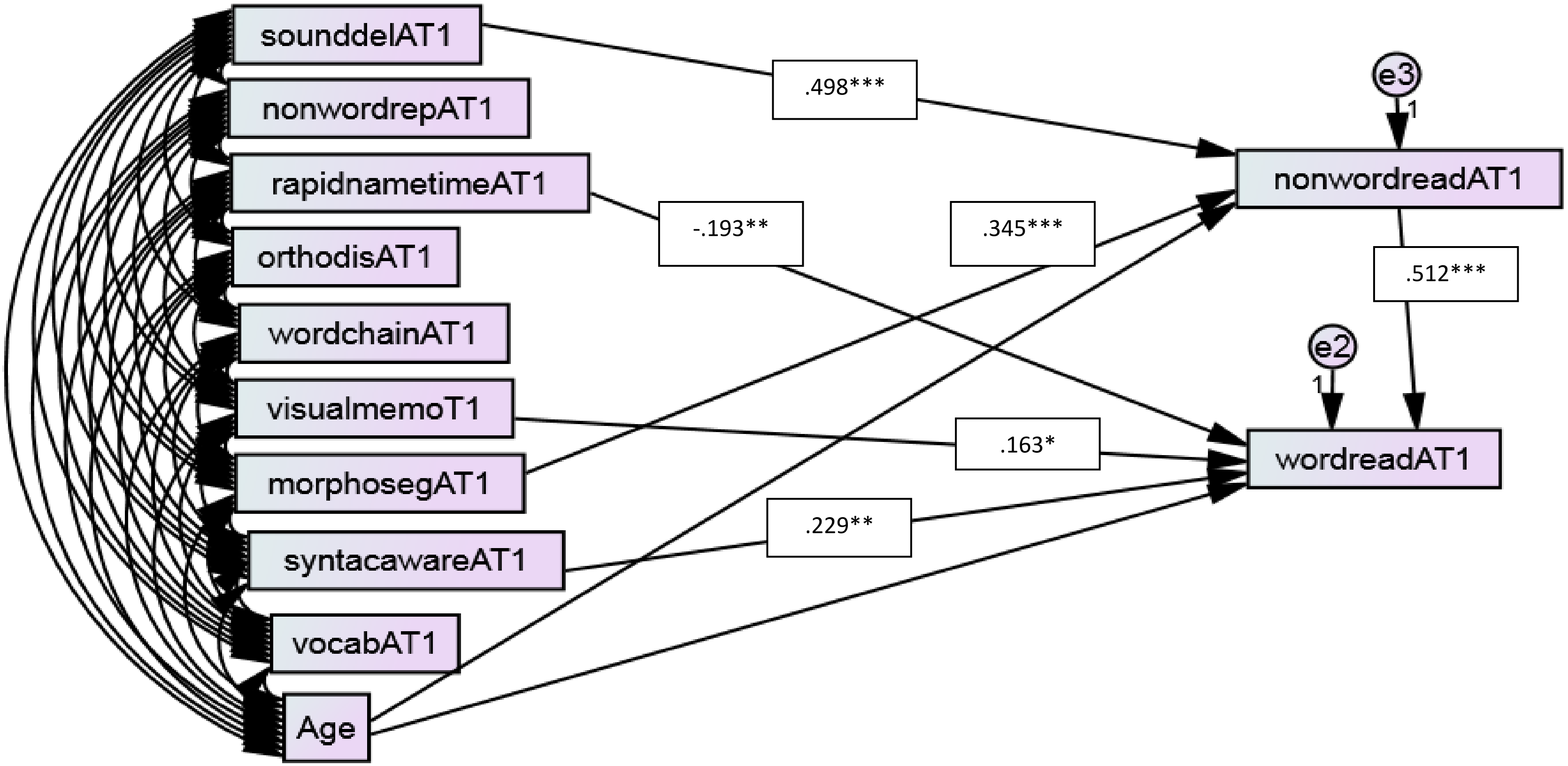
English Word Reading Model

The first model included all possible correlations between measures at Time 1, and with all possible paths from Time 1 variables in addition to decoding (that was used as mediator in the model) to Time 1 word reading and, from Time 1 phonological skills, orthographic skills and vocabulary (based on regression findings, though vocabulary is reinvestigated in this model) to Time 1 decoding. Age was controlled for as discussed before. We allowed the Time 1 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (2) = .625, p=.731, CFI=1.000, RMSEA=.000, PCLOSE=.769. To build a simpler model, we used variables with significant paths only (See Figure 5.2). The model provided a good fit to the data set: $\chi 2$ (13) = 9.832, p=.708, CFI=1.000, RMSEA=.000, PCLOSE=.822. The model confirms the previous finding that decoding, predicts Time 1 English word reading. However, the model indicates that Time 1 morpho-syntactic awareness is directly related English word reading, while word chain, sound deletion, and vocabulary are indirectly related to word reading via decoding.

Arabic Text Reading Fluency Model

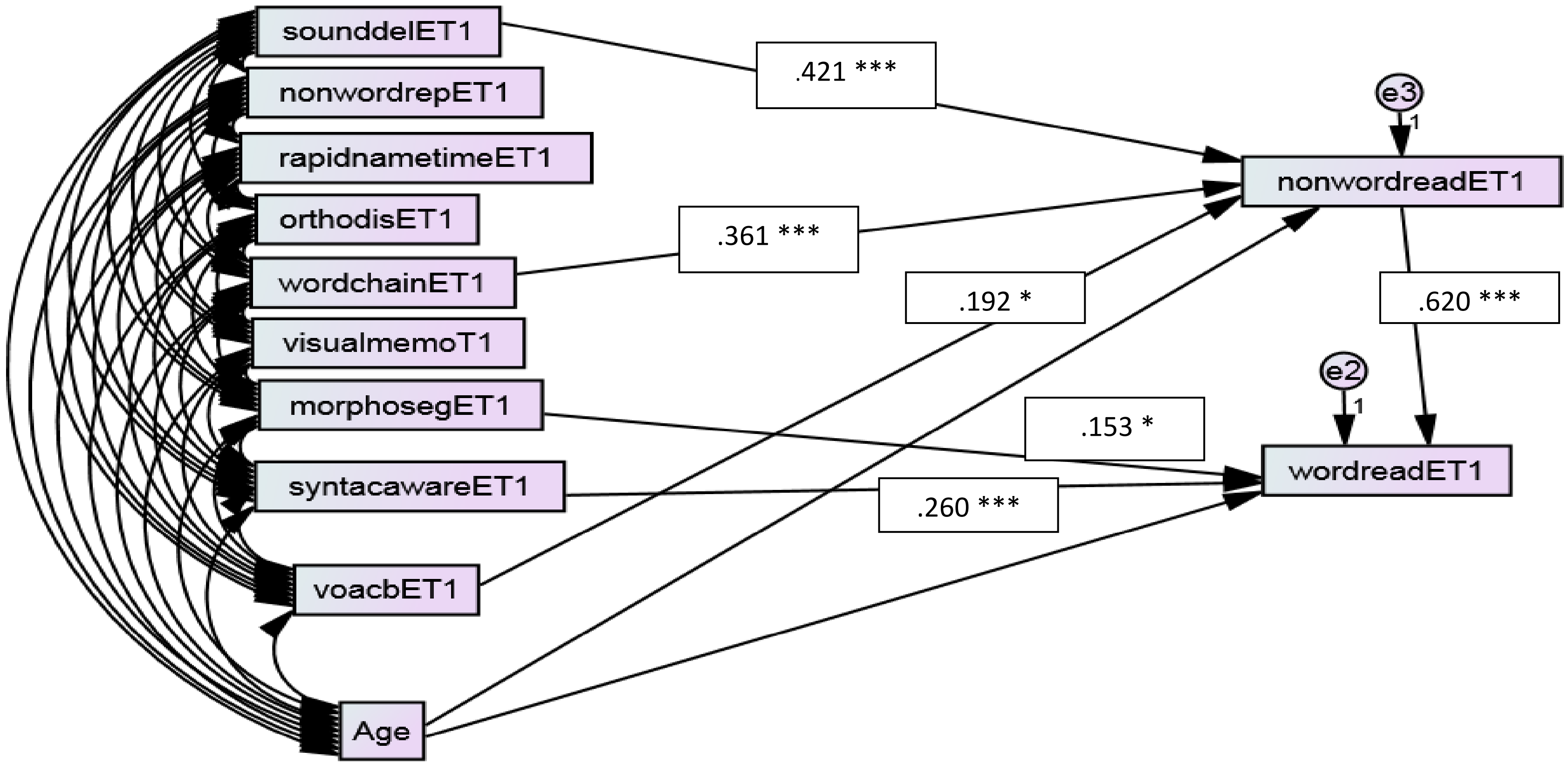
Based on Arabic Word Reading Model (See Figure 5.1), the first model included all possible correlations between measures at Time 1, and with paths from Time 1 sound deletion and morphological segmentation to decoding (that was used as mediator in the model), and from to Time 1 decoding, RAN, visual memory, and syntactic awareness to Time 1 word reading (that was also used as a mediator). Finally, we had paths from all Time 1 variables (including decoding and word reading to Time 1 Text Reading Fluency. Age was controlled for as previously discussed. We allowed the Time 1 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (13) = 14.489, p=.340, CFI=.995, RMSEA=.040, PCLOSE=.503. To build a simpler model, we used variables with significant paths only (See Figure 5.3). The model provided a good fit to the data set: $\chi 2$ (21) = 25.906, p=.210, CFI=.98477, RMSEA=.058, PCLOSE=.397. The model confirms the previous finding that word reading and phonological processing (sound deletion and RAN) predict Time 1 Arabic Text Reading Fluency. The model also indicates that Time 1 RAN, visual memory and syntactic awareness are indirectly related Text Reading Fluency via word reading and that morphological segmentation is also indirectly related to fluency via decoding and hence word reading.

Figure 5.1 Path diagram to show the concurrent relations between variables from Time 1 to Time 1 Arabic Word Reading.



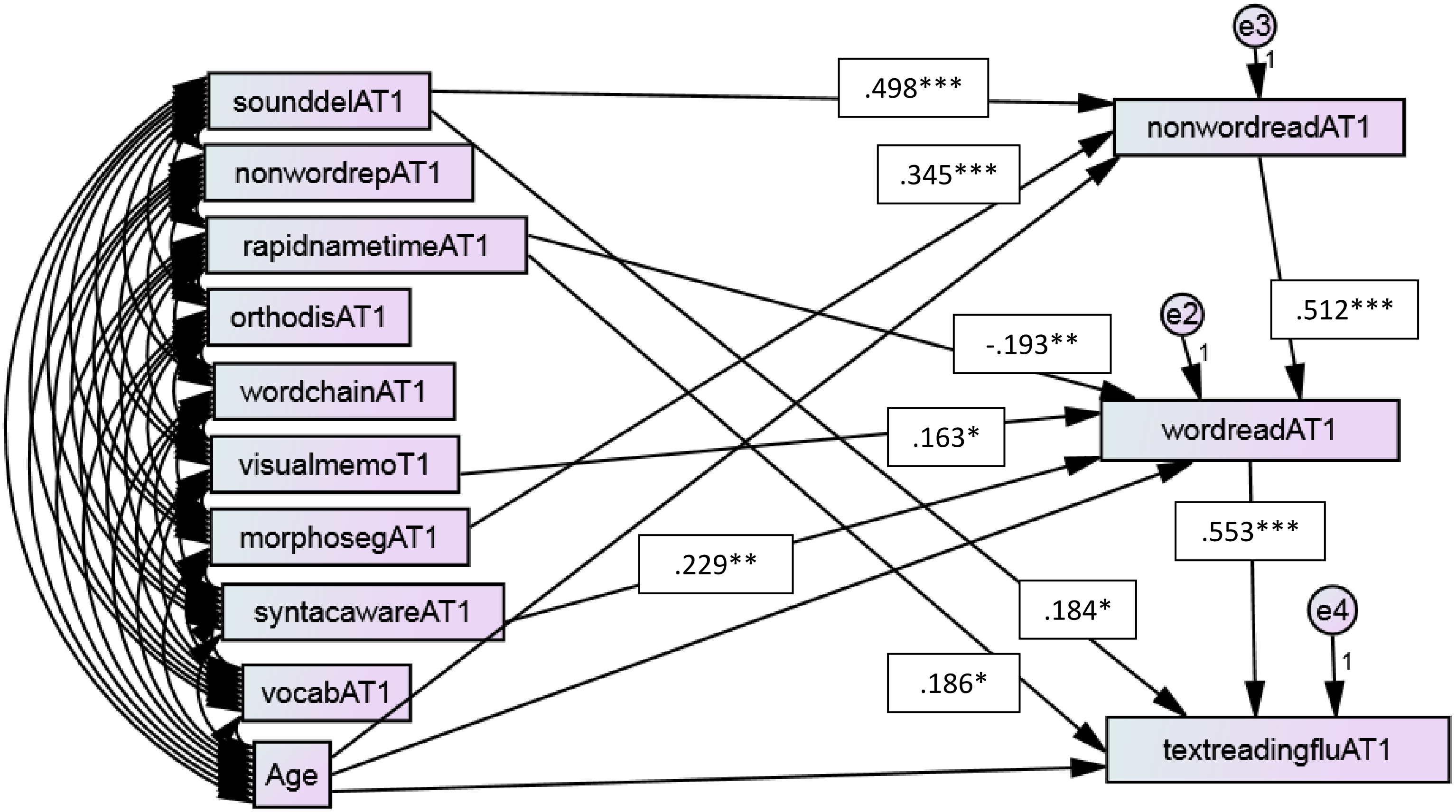
Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

Figure 5.2 Path diagram to show the concurrent relations between variables from Time 1 to Time 1 English Word Reading.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$.

Figure 5.3 Path diagram to show the concurrent relations between variables from Time 1 to Time 1 Arabic Text Reading Fluency.



Note. Numbers in the figure are standardised regression weights. ∗p=.05. ∗∗p=.01.∗∗∗p < .001

English Text Reading Fluency Model

Based on English Word Reading Model (See Figure 5.2), the first model included all possible correlations between measures at Time 1, and with paths from Time 1 sound deletion, word chain and vocabulary to decoding (that was used as a mediator in the model), and from to Time 1 decoding, RAN and morpho-syntactic skills to Time 1 word reading (that was also used as a mediator). Finally, we had paths from all Time 1 variables (including decoding and word reading to Time 1 Text Reading Fluency. We allowed the Time 1 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (13) = 9.832, p=.708, CFI=1.000, RMSEA=.000, PCLOSE=.822. To build a simpler model, we used variables with significant paths only (See Figure 5.4). The model provided a good fit to the data set: $\chi 2$ (21) = 17.967, p=.651, CFI=1.000, RMSEA=.000, PCLOSE=.811. The model confirms the previous finding that word reading and orthographic awareness (word chain) predict Time 1 Arabic Text Reading Fluency. The model also indicates that Time 1 morphological segmentation is directly related Text Reading Fluency. In addition, it adds that morpho-syntactic skills are related to English Reading Fluency via word reading, and that sound deletion and vocabulary are indirectly related to fluency via decoding and hence word reading.

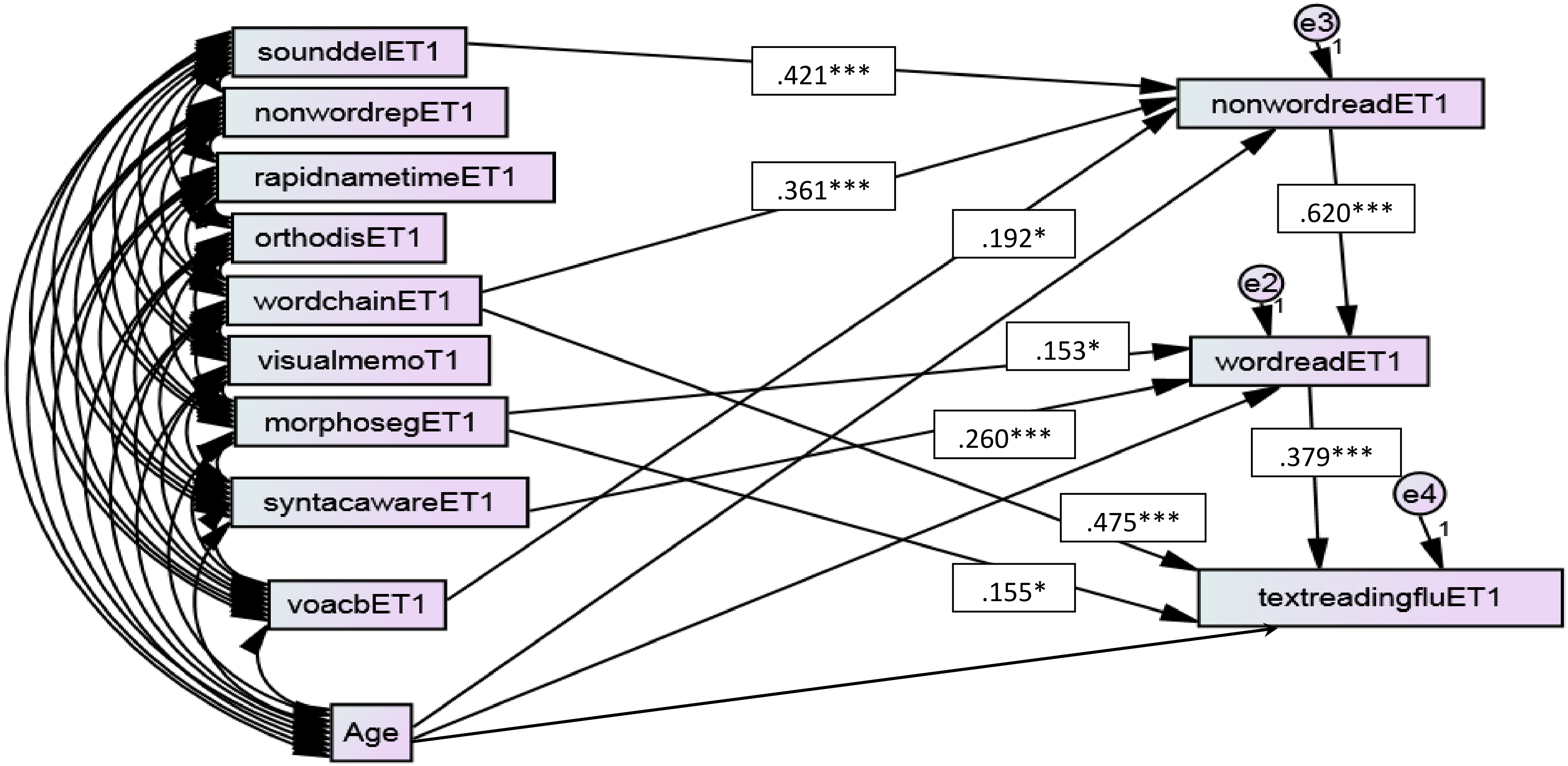
Arabic Word Spelling Model

Based on regression findings, the first model included paths from Time 1 phonological processing and morpho-syntactic processing to decoding (that was used as a mediator in the model), and from to Time 1 variables (including decoding) to Time 1 Arabic Word Spelling, with all possible correlations between measures at Time 1. We allowed the Time 1 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (4) = 4.180, p=.382, CFI=.999, RMSEA=.025, PCLOSE=.472. To build a simpler model, we used variables with significant paths only (See Figure 5.5). The model provided a good fit to the data set: $\chi 2$ (14) = 18.071, p=.204, CFI=.982, RMSEA=.064, PCLOSE=.353. The model confirms the previous finding that word decoding and phonological awareness (RAN has a direct relation to word spelling while sound deletion has an indirect relation via decoding) predict Time 1 Arabic Word Spelling. The model also indicates that Time 1 word chain is directly related to Arabic Word Spelling and that Time 1 morphological segmentation is indirectly related to it via decoding.

English Word Spelling Model

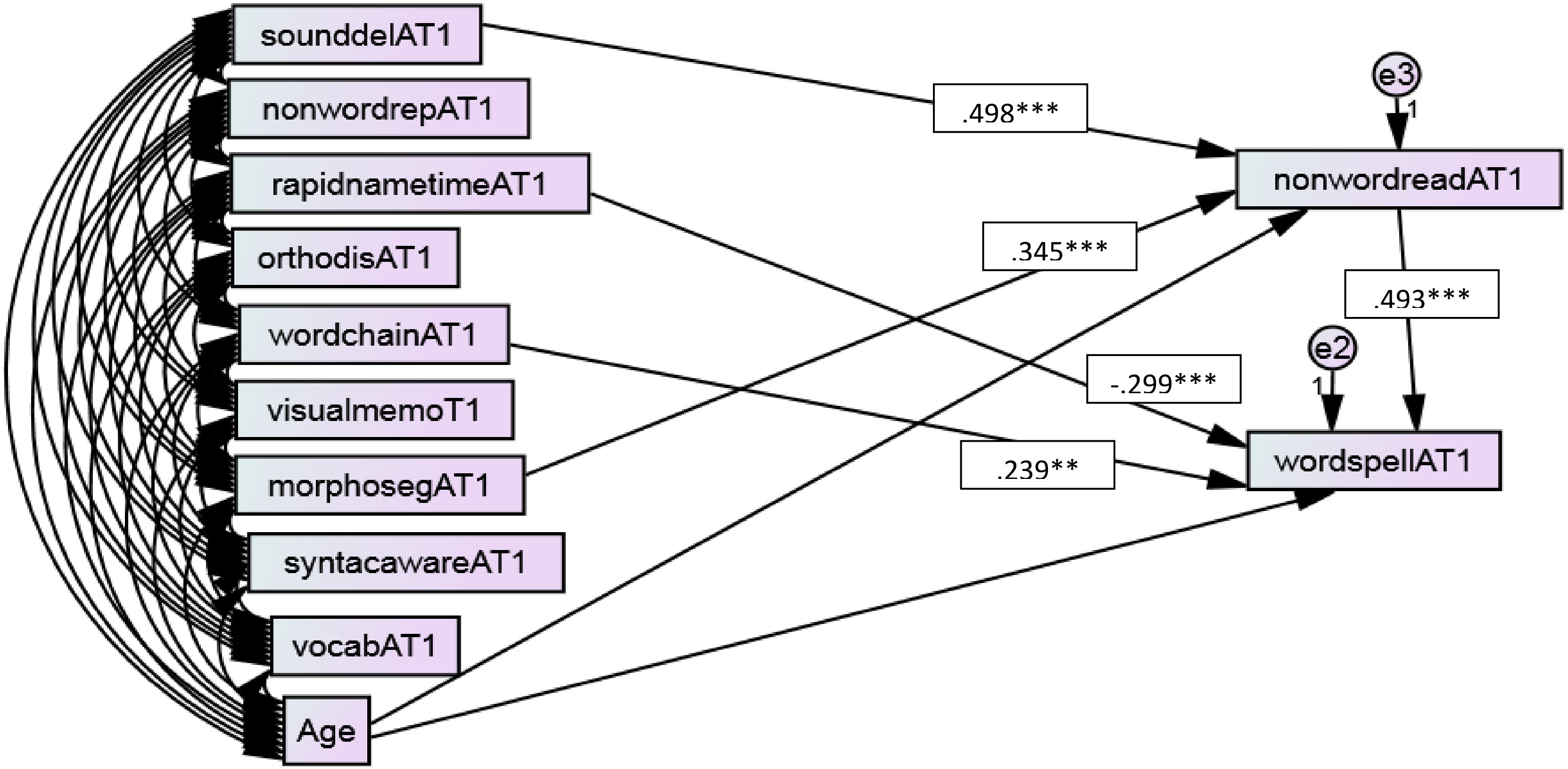
Based on regression findings, the first model included paths from Time 1 phonological and orthographic processing (we added vocabulary since it showed variability in the English Word Reading Model) to decoding (which was used as a mediator in the model), and from to Time 1 variables (including decoding) to Time 1 English Word Spelling, with all possible correlations between measures at Time 1. We allowed the Time 1 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (2) = .625, p=.731, CFI=1.000, RMSEA=.000, PCLOSE=.769. To build a simpler model, we used variables with significant paths only (See Figure 5.6). The model provided a good fit to the data set: $\chi 2$ (14) = 11.045, p=.682, CFI=1.000, RMSEA=.000, PCLOSE=.808. The model confirms the previous finding that word decoding and orthographic processing (word chain) have direct relations to word spelling. It also shows that sound deletion and vocabulary have indirect relations (via decoding) to Time 1 English Word Spelling.

Figure 5.4 Path diagram to show the concurrent relations between variables from Time 1 to Time 1 English Text Reading Fluency.



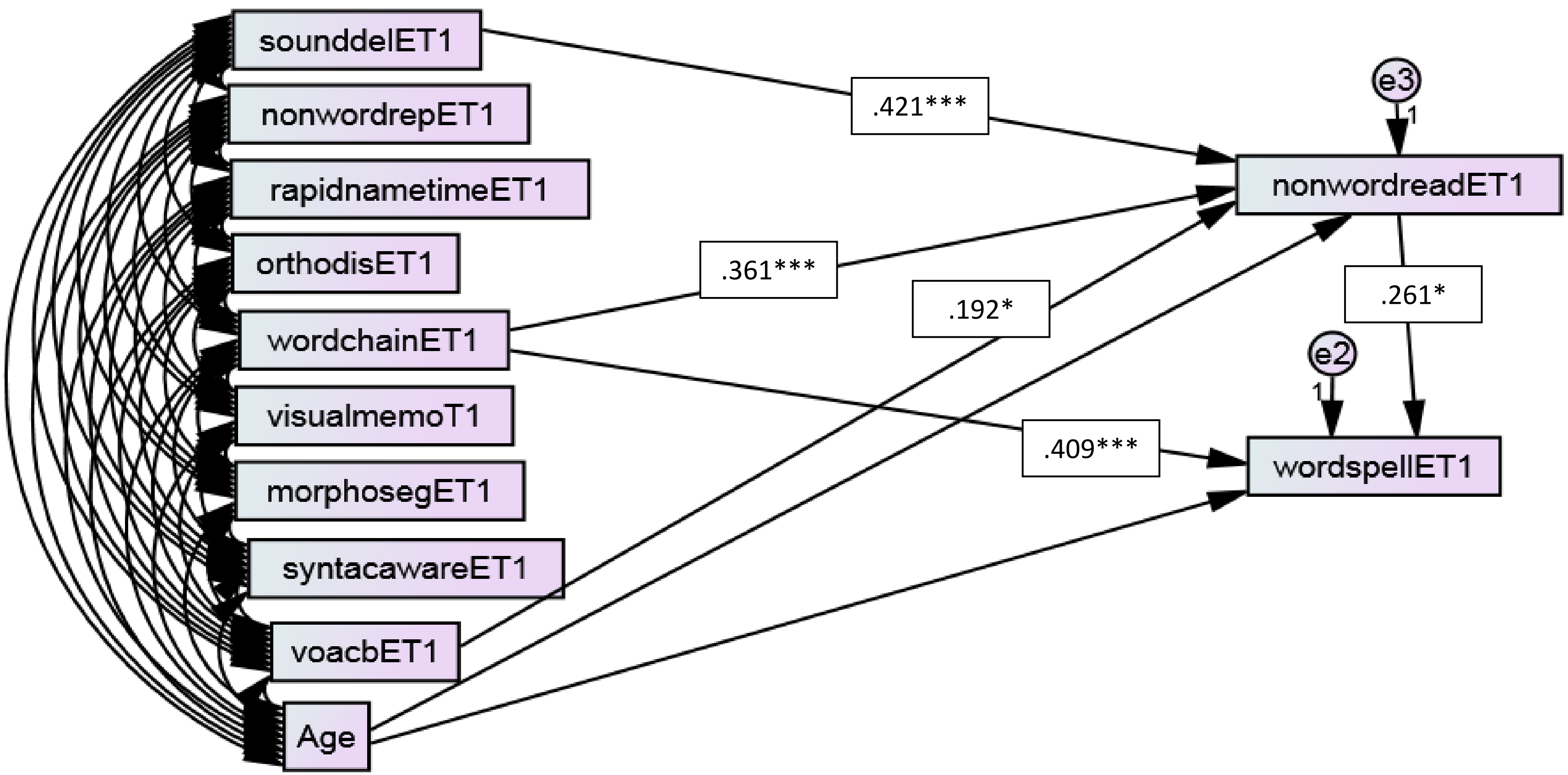
Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001

Figure 5.5 Path diagram to show the concurrent relations between variables from Time 1 to Time 1 Arabic Word Spelling.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001

Figure 5.6 Path diagram to show the concurrent relations between variables from Time 1 to Time 1 English Word Spelling



Note. Numbers in the figure are standardised regression weights. ∗*p*=.05. ∗∗*p*=.01.∗∗∗*p* < .001

Time 2

Table 5.21 demonstrates the descriptive data analysis of Time 2 for Arabic and English measures and the non-language measure. The table shows the means, standard deviations (in round brackets), minimum-maximum scores, and maximum possible scores (in square brackets). Tables 5.22 and 5.23 demonstrate correlations within Time 2 for Arabic and English measures (respectively) and the non-language measures. Table 5.22 demonstrates correlations across languages in Time 2.

Table 5.21. Descriptive data analysis at Time 2, Means, with standard deviations in round brackets, minimum-maximum scores, and the maximum possible scores in square brackets, for the measures in the Study for Arabic and English measures and the non-language measure

	Arabic	**English**
Word Reading	15.84 (7.20) 0-29 [30]	11.03 (7.66) 0-28 [30]
Text Reading Fluency	.48 (.35) .01-1.31	.32 (.28) 0-1.42
Word Spelling	24.06 (7.28) 9-37 [38]	18.61 (6.28) 5-36 [38]
Non-word Reading	9.54 (5.43) 0-22 [25]	8.26 (5.41) 0-20 [25]
Vocabulary	27.86(8.16) 5-42 [43]	25.15 (8.14) 5-43 [45]
Word Chain	6.81 (6.53) 0-20 [20]	5.41 (4.57) 0-18 [20]

Table 5.22 Correlations within Time 2 for Arabic measures and the non-language measures.

Arabic Time 2	word reading	text reading fluency	word spelling	Non-word Reading	Vocabulary
word reading					
text reading fluency	.807**				
word spelling	.806**	.700**			
Non-word Reading	.734**	.586**	.693**		
Vocabulary	.452**	.508**	.517**	.374**	
Word Chain	.436**	.368**	.506**	.409**	.287**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Tables 5.23 Correlations within Time 2 for English measures and the non-language measures.

English Time 2	word reading	text reading fluency	word spelling	Non-word Reading	Vocabulary
word reading					
text reading fluency	.854**				
word spelling	.800**	.753**			
Non-word Reading	.865**	.750**	.720**		
Vocabulary	.449**	.399**	.503**	.401**	
Word Chain	.728**	.740**	.693**	.694**	.385**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Table 5.24 Correlations across languages in Time 2

English \ Arabic	word reading	text reading fluency	word spelling	Non-word Reading	vocabulary	word chain
word reading	.720**	.678**	.714**	.587**	.394**	.567**
text reading fluency	.591**	.658**	.564**	.478**	.236*	.527**
word spelling	.630**	.526**	.653**	.504**	.247*	.515**
Non-word Reading	.778**	.666**	.709**	.675**	.384**	.495**
Vocabulary	.308**	.283*	.329**	.109	.411**	.136
Word Chain	.483**	.478**	.560**	.426**	.135	.618**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

From Table 5.21, it appears that all skills in Arabic are higher than their counterparts in English. Table 5.22 shows the correlations within Time 2 for Arabic measures and the non-language measures. The table shows that all literacy measures (Arabic word reading, text reading fluency and Arabic word spelling) correlated with non-word reading, vocabulary, and word chain. Table 5.23 shows the correlations within Time 2 for English measures and the non-language measures. The table shows that English was similar to Arabic since all literacy measures (English word reading, text reading fluency and English word spelling) correlated with non-word reading, vocabulary and word chain. Table 5.24 shows correlations across languages in Time 2. It is clear from the table that all skills in Arabic correlated with their counterparts in English. The table also shows that Arabic literacy correlated with English, non-word reading, vocabulary and word chain. It also shows that English literacy correlated with Arabic non-word reading, vocabulary and word chain.

Regression analyses were performed to investigate variance by each measure in Time2. The dependent variables were similar to Time 1: Arabic Word Reading Arabic, English Word Reading, Arabic Text Reading Fluency, English Text Reading Fluency, Arabic Word Spelling, English Word Spelling, Arabic Word Decoding and English Word Decoding. The independent variables were decoding skills (except for regression on decoding when it is the dependent variable itself), vocabulary, and orthographic processing (word chain). Variables were entered as explained at the beginning of this chapter.

In the first set of analysis, Arabic word reading was the dependent variable. Table 5.25 shows the regression analysis done to express variance by decoding, vocabulary, and orthographic processing skills. The final beta scores show that the main predictor was decoding (beta score = .609), followed by vocabulary (beta score = .187), then orthographic processing (beta score= .145). The data in the table show that when vocabulary was entered first, it explained 20.6% while decoding explained 37% variance of Arabic word reading. When decoding was entered first, it explained 54% of variance while vocabulary explained 3.7% only. When controlling for age, decoding and vocabulary orthographic processing did not add any unique variance to Arabic word reading. It can be concluded from this set of analyses that the main predictor of Time 2 Arabic word reading is mainly decoding, in addition to vocabulary.

In the second set of analyses (see Table 5.26), English word reading was the dependent variable. The final beta scores show that the main predictor for English word reading was decoding (beta score = .682). The data in the table (see analyses I, II and III) show that when vocabulary was entered first, it explained 20.5% while decoding explained 55.4% variance of English word reading. When decoding was entered first, it explained 74.5% of variance while vocabulary explained 1.3% only. Orthographic processing explained only 1.8% of Arabic word reading variability. When controlling for age and both decoding and orthographic processing (see analyses IV), vocabulary did not add any unique variance. It can be concluded from this set of analyses that the main predictor of English word reading is decoding, in addition to orthographic processing (word chain).

In the third set of analyses (see Table 5.27), Arabic text reading was the dependent variable. The independent variables were word reading, decoding, vocabulary and word chain. The final beta scores show that the main predictor was word reading (beta score = .744). The data in the table show that when controlling for age and word reading, decoding, vocabulary, and word chain did not add unique variance. When controlling for age and word reading only, explained only 2 % of unique variance of Arabic text reading (note that p=.056). It can be concluded from this set of analyses that the main predictor of Arabic text reading fluency is word reading.

<table>
<tr><td colspan="8">Table 5.25 Regression analysis to investigate predictors of Arabic word reading in Time 2</td></tr>
<tr><td></td><td></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>vocabulary</td><td>.207</td><td>.206</td><td>F(1,77)=19.972 p=.000</td><td colspan="2">.187</td></tr>
<tr><td>2</td><td>decoding</td><td>.577</td><td>.370</td><td>F(1,76)=66.571 p=.000</td><td colspan="2">.609</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>decoding</td><td>.540</td><td>.539</td><td colspan="3">F(1,77)=90.218 p=.000</td></tr>
<tr><td>2</td><td>vocabulary</td><td>.577</td><td>.037</td><td colspan="3">F(1,76)=6.679 p=.012</td></tr>
<tr><td></td><td>4</td><td>orthographic processing</td><td>.592</td><td>.015</td><td>F(1,75)=2.711 p=.104</td><td>word chain</td><td>.145</td></tr>
</table>

<table>
<tr><td colspan="8">Table 5.26 Regression analysis to investigate predictors of English word reading in Time 2</td></tr>
<tr><td></td><td></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>vocabulary</td><td>.207</td><td>.205</td><td>F(1,76)=19.618 p=.000</td><td colspan="2">.102</td></tr>
<tr><td>2</td><td>decoding</td><td>.761</td><td>.554</td><td>F(1,75)=173.383 p=.000</td><td colspan="2">.682</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>decoding</td><td>.747</td><td>.745</td><td colspan="3">F(1,76)=224.278 p=.000</td></tr>
<tr><td>2</td><td>vocabulary</td><td>.761</td><td>.013</td><td colspan="3">F(1,75)=4.093 p=.047</td></tr>
<tr><td>III</td><td>3</td><td>orthographic processing</td><td>.778</td><td>.018</td><td>F(1,74)=5.943 p=.017</td><td>word chain</td><td>.195</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td rowspan="3">IV</td><td>1</td><td>decoding</td><td>.747</td><td>.745</td><td colspan="3">F(1,76)=224.278 p=.000</td></tr>
<tr><td>2</td><td>orthographic processing</td><td>.770</td><td>.022</td><td colspan="3">F(1,75)=7.330 p=.008</td></tr>
<tr><td>3</td><td>vocabulary</td><td>.778</td><td>.008</td><td colspan="3">F(1,74)=2.800 p=.098</td></tr>
</table>

In the fourth set of analyses (see Table 5.28), English text reading was the dependent variable. The independent variables were word reading, decoding, vocabulary and word chain. The final beta scores show that the main predictor was word reading (beta score = .643). The data in the table show that when controlling for age and word reading, all the other variables became insignificant, except for word chain that added 3% of unique variance. It can be concluded from this set of analyses that the main predictor of English Text Reading Fluency is mainly decoding, in addition to orthographic processing.

Table 5.27 Regression analysis to investigate predictors of Arabic text reading in Time 2						
	Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
1	word reading	.653	.652	F(1,75)= 141.057 p=.000	.744	
2	decoding	.653	.000	F(1,74)=.001 p=.975	-.010	
3	vocabulary	.670	.017	F(1,73)= 3.715 p=.058	.149	
4	orthographic processing	.670	.000	F(1,72)=.000 p=.998	word chain	.000
1	word reading	.653	.652	F(1,75)= 141.057 p=.000		
2	vocabulary	.670	.017	F(1,74)=3.755 p=.056		

Table 5.28 Regression analysis to investigate predictors of English text reading in Time 2						
	Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
1	word reading	.738	.711	F(1,71)= 192.336 p=.000	.643	
2	decoding	.740	.002	F(1,70)=.609 p=.438	-.012	
3	vocabulary	.746	.006	F(1,69)=1.542 p=.219	.063	
4	orthographic processing	.777	.032	F(1,68)=9.630 p=.003	word chain	.265

In the fifth set of analyses (see Table 5.29), Arabic word spelling was the dependent variable. The final beta scores show that the main predictor was decoding (beta score = .502). The data in the table show that after controlling for age when vocabulary was entered first (see analyses I, II and III), it explained 26.8% while decoding explained 29% variance of Arabic word spelling. However, when decoding was entered first, it explained 48% of variance while vocabulary explained 0.7% only. Orthographic processing added 4% of unique variability. When controlling for age, decoding and orthographic processing (see analyses IV), vocabulary still added 6% of unique variance. It can be concluded from this set of analyses that the predictors of Arabic word spelling are decoding, vocabulary and orthographic processing.

In the sixth set of analyses (see Table 5.30), English word spelling was the dependent variable. The final beta scores show that the main predictor was decoding (beta score

= .410), followed by orthographic processing (beta score = .329). The data in the table show that after controlling for age, and entering vocabulary in the first step (see analyses I, II and III), it explained 25.3% while decoding explained 32.2% variance of Arabic word spelling. However, when decoding was entered first, it explained 52% of variance while vocabulary explained 5.3%. Orthographic processing added 5.5% of unique variability. When controlling for age, decoding and orthographic processing (see analyses IV), vocabulary still added 4% of unique variance. It can be concluded from this set of analyses that the predictors of English word spelling are decoding, orthographic processing and vocabulary.

Table 5.29 Regression analysis to investigate predictors of Arabic word spelling in Time 2

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	vocabulary	.268	.268	F(1,77)=28.186 p=.000	.265	
	2	decoding	.558	.290	F(1,76)=49.931 p=.000	.502	
II	1	decoding	.481	.481	F(1,77)=71.291 p=.000		
	2	vocabulary	.558	.077	F(1,76)=13.325 p=.000		
	3	orthographic processing	.600	.041	F(1,75)=7.728 p=.007	word chain	.226
III	1	decoding	.481	.481	F(1,77)=71.291 p=.000		
	2	orthographic processing	.541	.060	F(1,76)=9.880 p=.002		
	3	vocabulary	.600	.059	F(1,75)=11.047 p=.001		

In the seventh set of analyses (see Table 5.31), Arabic word decoding was the dependent variable. The independent variables were vocabulary and orthographic processing. The data in the table show that when controlling for age, vocabulary explained 14% variance of Arabic word decoding while orthographic processing explained 17%. When controlling for age and vocabulary, orthographic processing explained 10% of variance and when controlling for age and orthographic processing, vocabulary explained 7%. Results from this set of analyses indicate that the main predictor of Arabic word decoding is orthographic processing in addition to vocabulary.

In the eighth set of analyses (see Table 5.32), English word decoding was the dependent variable. The independent variables were vocabulary and orthographic processing.

Table 5.30 Regression analysis to investigate predictors of English word spelling in Time 2

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	vocabulary	.254	.253	F(1,77)=26.084 p=.000	.210	
	2	decoding	.575	.322	F(1,76)=57.583 p=.000	.410	
II	1	decoding	.522	.521	F(1,77)=84.020 p=.000		
	2	vocabulary	.575	.053	F(1,76)=9.519 p=.003		
III	3	orthographic processing	.630	.055	F(1,75)=11.072 p=.001	word chain	.329
IV	1	decoding	.522	.521	F(1,77)=84.020 p=.000		
	2	orthographic processing	.594	.072	F(1,76)=13.467 p=.000		
	3	vocabulary	.630	.036	F(1,75)=7.274 p=.009		

Table 5.31 Regression analysis to investigate predictors of Arabic word decoding in Time 2

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	Vocabulary	.140	.140	F(1,77)= 12.551 p=.001	.280	
	2	orthographic discrimination	.240	.099	F(1,76)= 9.935 .002	word chain	.329
II	1	orthographic discrimination	.168	.168	F(1,77)= 15.494 p=.000		
	2	vocabulary	.240	.072	F(1,76)= 7.201 p=.009		

Table 5.32 Regression analysis to investigate predictors of English word decoding in Time 2

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	Vocabulary	.165	.163	F(1,77)= 15.041 p=.000	.159	
	2	orthographic discrimination	.503	.338	F(1,76)= 51.772 p=.000	word chain	.631
II	1	orthographic discrimination	.482	.480	F(1,77)= 71.311 p=.000		
	2	Vocabulary	.503	.022	F(1,76)= 3.295 p=.73		

Path Analyses

Arabic Word Reading Model

When trying to build a model for Arabic word reading (with decoding as a mediator), the model did not fit even after deleting the insignificant paths: $\chi 2$ (2) =4.593, p=.101, CFI=.969, RMSEA=.136 PCLOSE=.142. When trying to build a model without decoding as a mediator (we covaried decoding with word chain and vocabulary), the model gave the same fit. In addition, vocabulary was insignificant (it was only significant at level 0.1)

English Word Reading Model

When trying to build a model for English word reading (with decoding as mediator), the model did not fit even after deleting the insignificant paths: $\chi 2$ (1) =2.177, p=.140, CFI=.993, RMSEA=.130 PCLOSE=.174. When trying to build a model without decoding as a mediator (we covaried decoding with word chain and vocabulary), the model gave the same fit.

Arabic Text Reading Fluency Model

The initial model (with decoding as a mediator) did not provide a good fit to the data set. After deleting the insignificant paths, the model did not improve either: $\chi 2$ (5) = 14.345, p=.014, CFI=.941, RMSEA=.163, PCLOSE=.031. However, when making a model with decoding covaried with other exogenous variables, the final model (after deleting the insignificant paths) provided a good fit: $\chi 2$ (4) = 5.047, p=.282, CFI=.993, RMSEA=.061, PCLOSE=.369 (See Figure 5.7). The model confirms the findings of the regression analysis that Time 2 Word Reading is a predictor of Text Reading Fluency. However, it also shows that vocabulary is directly related to Text Reading Fluency and that decoding is directly related to Fluency via Word Reading.

English Text Reading Fluency Model

Based on regression results, the initial hypothesised model included paths from word chain to decoding and from word chain and decoding to word reading. Then we added paths from all variables to Text Reading Fluency. The model did not provide a good fit: $\chi 2$ (3) = 6.275, p=.099, CFI=.988, RMSEA=.125, PCLOSE=.148. However, after deleting the insignificant paths, the model provided a better fit: $\chi 2$ (5) = 7.584, p=.181, CFI=.990, RMSEA=.086, PCLOSE=.265. When trying to build a model with decoding covaried with word chain and vocabulary (See Figure 5.8), the final model provided a better fit than the model with decoding as a mediator: $\chi 2$ (3) = 3.485, p=.323, CFI=.998, RMSEA=.048, PCLOSE=.399. However, the results of the models were the same: direct predictors of English Text Fluency were word reading Word chain, and both word chain and decoding were indirectly related to Fluency via Word Reading.

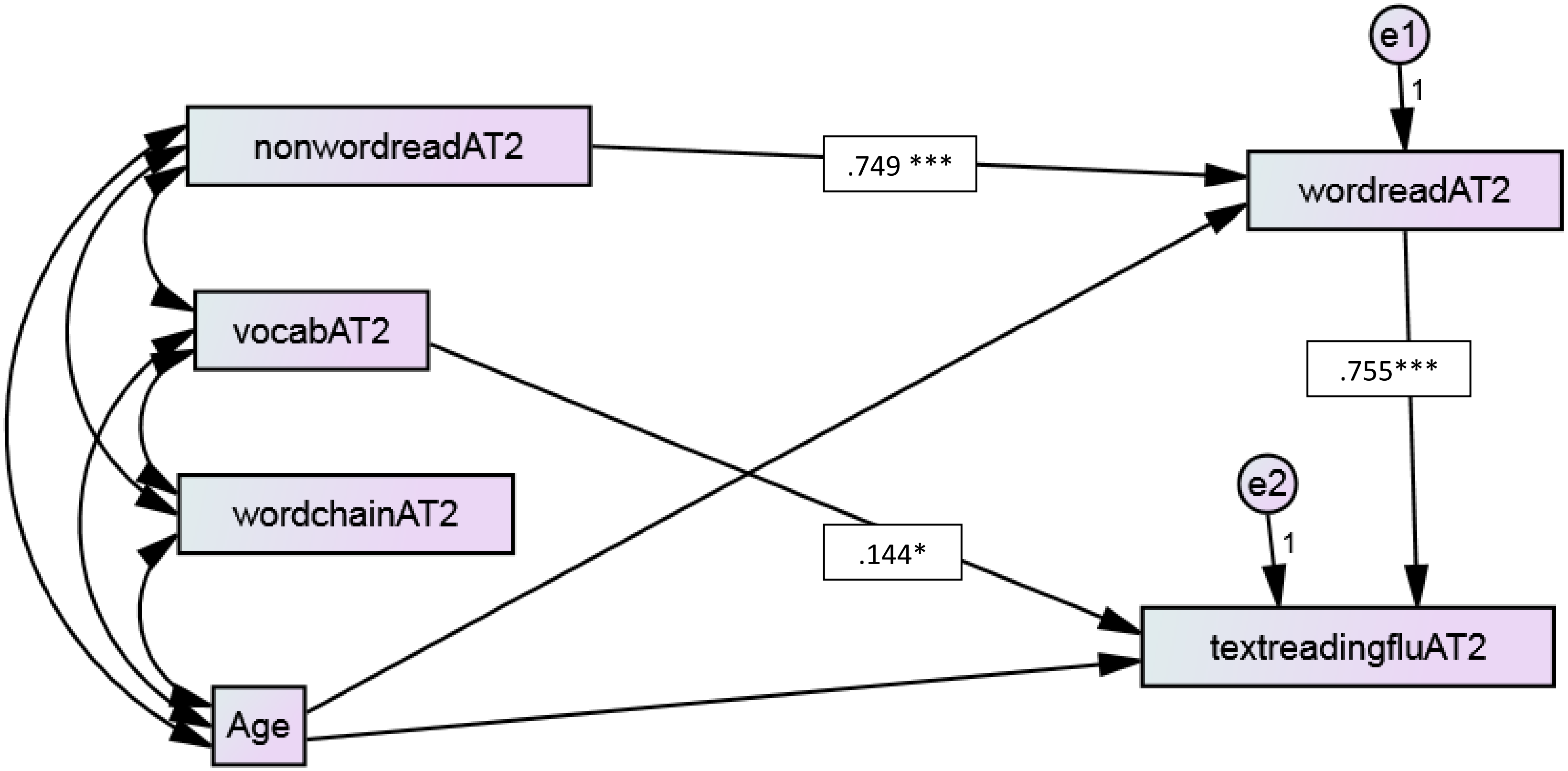
Arabic Word Spelling Model

When trying to build a model for Arabic word spelling (with decoding as a mediator), the model did not fit even after deleting the insignificant paths: $\chi 2$ (1) = 3.364, p=.067, CFI=.971, RMSEA=.184 PCLOSE=.091. When trying to build a model without decoding as a mediator (we covaried decoding with word chain and vocabulary), the model gave the same fit.

English Word Spelling Model

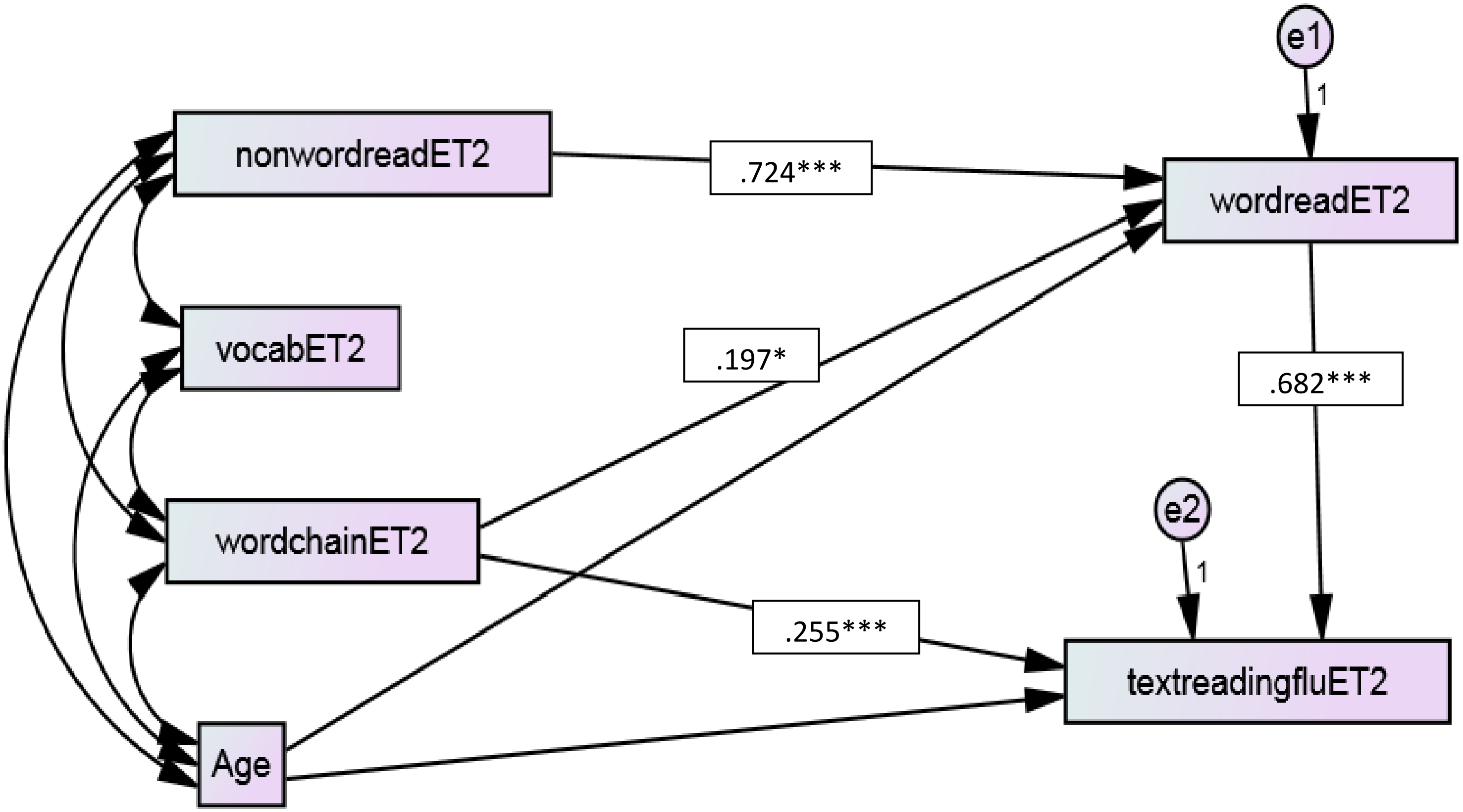
When trying to build a model for English word spelling (with decoding as a mediator), the model did not fit: $\chi 2$=.000 and probability could not be completed, CFI=1.000, RMSEA=.423 PCLOSE=.000. The saturated model could not be trimmed since all paths were significant. When trying to build a model without decoding as a mediator (we covaried decoding with word chain and vocabulary), the model gave the same fit.

Figure 5.7 Path diagram to show the concurrent relations between variables from Time 2 to Time 2 Arabic Text Reading Fluency



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001

Figure 5.8 Path diagram to show the concurrent relations between variables from Time 2 to Time 2 English Text Reading Fluency



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001

Time 3

Table 5.33 demonstrates the descriptive data analysis of Time 3 for Arabic and English measures and the non-language measure. The table shows the means, standard deviations (in round brackets), minimum-maximum scores, and maximum possible scores (in square brackets). Tables 5.34 and 5.35 demonstrate correlations within Time 3 for Arabic and English measures (respectively) and the non-language measures. Table 5.36 demonstrates correlations across languages in Time 3.

Table 5.33. Descriptive data analysis at Time 3, Means, with standard deviations in round brackets, minimum-maximum scores, and the maximum possible scores in square brackets, for the measures in the Study for Arabic and English measures and the non-language measure

	Arabic	**English**
Word Reading	13.71 (6.96) 0-29 [30]	12.49 (7.65) 0-30 [30]
Text Reading Fluency	.54 (.39) 0-1.53	.44 (.04) 0-1.48
Word Spelling	25.33 (7.78) 9-38 [38]	20.76 (6.77) 7-36 [38]
Vocabulary	29.67 (7.42) 11-41 [43]	27.15 (7.55) 10-43 [45]
Non-word Reading	8.57 (5.73) 0-22 [25]	7.92 (5.39) 0-22 [25]
Rapid Naming	48.04 (12.96) 26-84	68.08 (20.91) 31-130
Syntactic Awareness	18.58 (3.43) 10-24 [25]	16.21 (3.89) 9-25 [25]
Morphological Segmentation	15.31 (6.83) 1-25 [25]	9.78 (4.31) 0-20 [25]
Orthographic Discrimination	16.78 (8.12) 2-42 [50]	19.10 (7.51) 6-41 [50]
Word Chain	5.78 (6.03) 0-20 [20]	5.17 (5.30) 0-20 [20]

Tables 5.34 Correlations within Time 3 for Arabic measures and the non-language measures.

	word reading	text reading fluency	word spelling	Non-word Reading	Vocabulary	Rapid Naming	Orthographic Discrimination	word chain	Syntactic Awareness
word reading									
text reading fluency	.568**								
word spelling	.623**	.692**							
Non-word Reading	.722**	.503**	.518**						
vocabulary	.095	.277*	.292*	.135					
Rapid naming	- .074	- .461**	- .451**	- .180	- .373**				
Orthographic Discrimination	.267*	.452**	.387**	.219	.059	- .345**			
Word chain	.568**	.448**	.361**	.456**	.077	- .114	.124		
Syntactic Awareness	.356**	.654**	.653**	.295*	.478**	- .472**	.326**	.200	
Morphological Segmentation	.508**	.456**	.534**	.417**	.310**	- .135	.153	.509**	.467**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Tables 5.35 Correlations within Time 3 for English measures and the non-language measures.

English T3	word reading	text reading fluency	word spelling	Non-word Reading	Vocabulary	Rapid Naming	Orthographic Discrimination	word chain	Syntactic Awareness
word reading									
text reading fluency	.873**								
word spelling	.759**	.769**							
Non-word Reading	.862**	.761**	.661**						
vocabulary	.577**	.523**	.548**	.456**					
Rapid naming	- .461**	- .410**	- .497**	- .401**	- .420**				
Orthographic Discrimination	.352**	.419**	.461**	.297*	.288*	- .289*			
Word chain	.728**	.758**	.523**	.662**	.395**	- .220	.296*		
Syntactic Awareness	.563**	.555**	.664**	.548**	.461**	- .476**	.394**	.367**	
Morphological Segmentation	.574**	.584**	.404**	.499**	.332**	- .253*	.035	.492**	.439**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Tables 5.36 Correlations across languages Time 3.

English \ Arabic	word reading	text reading fluency	word spelling	Non-word Reading	Vocabulary	Rapid Naming	Orthographic Discrimination	word chain	Syntactic Awareness	Morphological Segmentation
word reading	.747**	.608**	.572**	.667**	.068	- .172	.382**	.478**	.266*	.545**
text reading fluency	.616**	.621**	.522**	.482**	.004	- .260*	.491**	.511**	.293*	.517**
word spelling	.555**	.579**	.702**	.511**	.150	- .353**	.439**	.343**	.451**	.454**
Non-word Reading	.681**	.524**	.522**	.638**	.105	- .233*	.410**	.504**	.279*	.523**
vocabulary	.390**	.297*	.383**	.361**	.187	- .171	.200	.155	.362**	.409**
Rapid naming	- .265*	- .418**	- .462**	- .246*	- .315**	.547**	- .259*	- .023	- .398**	- .208
Orthographic Discrimination	.259**	.343**	.358**	.163	- .040	- .230	.431**	.070	.152	.262*
Word chain	.610**	.379**	.360**	.460**	- .052	- .037	.285*	.678**	.131	.522**
Syntactic Awareness	.443**	.340**	.537**	.348**	.259*	- .396**	.332**	.091	.375**	.487**
Morphological Segmentation	.371**	.313**	.293*	.322**	.105	- .100	.216	.280*	.206	.486**

** Correlation is significant at the 0.01 level
 * Correlation is significant at the 0.05 level

From Table 5.33, it appears that all skills in Arabic are higher than their counterparts in English. Table 5.34 shows the correlations within Time 3 for Arabic measures and the non-language measures. The table shows that Arabic word reading correlated with decoding (non-word reading), orthographic processing, and morpho-syntactic processing. Both Arabic text reading fluency and Arabic word spelling, however, correlated with decoding, vocabulary (at level 0.05), phonological awareness, orthographic processing and morpho-syntactic processing. Table 5.35 shows the correlations within Time 3 for English measures and the non-language measures. The table shows that English word reading correlated with decoding and vocabulary, phonological processing, orthographic processing, and morpho-syntactic processing. Table 5.36 shows correlations across languages in Time 3. It is clear from the table that all skills in Arabic (except for vocabulary) correlated with their counterparts in English. The table also shows that Arabic literacy correlated with English decoding, vocabulary, phonological awareness, orthographic processing and morpho-syntactic processing. It also shows that English literacy correlated with Arabic decoding, phonological awareness (except for English word reading that did not correlate with Arabic rapid naming), orthographic processing and to morpho-syntactic processing.

Regression analyses were performed to investigate variance by each measure in Time3. The dependent variables, similar to Time 1 and Time 2 were Arabic word reading, English word reading, Arabic text reading, English text reading, Arabic word spelling and English word spelling. In each set of analyses, the independent variables were decoding skills, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The independent variables were entered in a set order as explained at the beginning of the chapter.

In the first set of analyses (see Table 5.37), Arabic word reading was the dependent variable. The final beta scores show that the main predictor is decoding (beta score = .556). The data in the table show that, when controlling for age decoding explained 53.6% variance of Arabic word reading. Both vocabulary and phonological awareness were insignificant. After controlling for all the previous variables, morpho-syntactic awareness explained only 3.3% of Arabic word reading variability; however, $p=.055$. Table 5.38 shows that after controlling for age, decoding and orthographic processing; morpho-syntactic awareness becomes insignificant. From this set of analyses, it could be concluded that the predictors of Arabic word reading in Time 3 are decoding and orthographic processing.

<table>
<tr><td colspan="7">Table 5.37 Regression analysis to investigate predictors of Arabic word reading in Time 3</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>vocabulary</td><td>.019</td><td>.013</td><td>F(1,69)=.907
P= .344</td><td colspan="2">- .035</td></tr>
<tr><td>2</td><td>decoding</td><td>.555</td><td>.536</td><td>F(1,68)=82.005
p= .000</td><td colspan="2">.556</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>decoding</td><td>.554</td><td>.548</td><td colspan="3">F(1,69)= 84.862
p= .000</td></tr>
<tr><td>2</td><td>vocabulary</td><td>.555</td><td>.001</td><td colspan="3">F(1,86)= .154
p= .696</td></tr>
<tr><td rowspan="3">III</td><td>3</td><td>phonological awareness</td><td>.559</td><td>.003</td><td>F(1,67)= .517
p= .474</td><td>rapid naming</td><td>.150</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">orthographic processing</td><td rowspan="2">.629</td><td rowspan="2">.070</td><td rowspan="2">F(2,65)= 6.178
p= .003</td><td>orthographic discrimination</td><td>.091</td></tr>
<tr><td>word chain</td><td>.217</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>orthographic processing</td><td>.619</td><td>.063</td><td colspan="3">F(2,66)= 5.491
p= .006</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.629</td><td>.010</td><td colspan="3">F(1,65)= 1.832
p=.181</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">5</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.662</td><td rowspan="2">.033</td><td rowspan="2">F(2,63)= 3.038
p= .055</td><td>syntactic awareness</td><td>.164</td></tr>
<tr><td>morphological segmentation</td><td>.115</td></tr>
</table>

Table 5.38 Regression analysis to investigate predictors of Arabic word reading in Time 3

	Variables	R^2	R^2 change	Sig R^2 change
1	decoding	.554	.548	F(1,69)= 84.862 p= .000
2	orthographic processing	.619	.064	F(2,67)= 5.644 p=.005
3	Morpho-syntactic awareness	.643	.025	F(2,65)= 2.235 p=.115

In the second set of analyses (see Table 5.39), English word reading was the dependent variable. The final beta scores show that the main predictor is decoding (beta score = .535). The data in 'Table 5.39' show that when controlling for age vocabulary explained 33% while decoding explained 74% of variance. When controlling for the previous variables, phonological awareness became insignificant while orthographic processing added 4% of unique variance. Morpho-syntactic processing became significant as well. Table 5.40 shows that when controlling for age and decoding vocabulary added 4% of unique variance while orthographic processing added 5%. The table also shows that both vocabulary and orthographic processing still added unique variance after controlling for all the other variables in the table. From this set of analyses, it could be concluded that the main predictor of English word reading in Time 3 is decoding in addition to vocabulary and orthographic processing.

In the third set of analyses (see Table 5.41), Arabic Text Reading Fluency was the dependent variable. Word reading, decoding, phonological awareness, orthographic processing, vocabulary and morpho-syntactic awareness were the independent variables. The final beta scores show that the main predictor was morpho-syntactic awareness (beta score= .399), followed by orthographic processing (beta score = .331). The data in the table show that when controlling for age and word reading, decoding did not add any significant variance. Both orthographic and phonological processing still added significant variance, even after reversing the order of their entry. When phonological awareness was entered before orthographic processing, it explained 16% while orthographic processing explained 5%. When the order was reversed, orthographic processing explained 12% of unique variability while phonological awareness explained only 9% of variability. Finally, when controlling for the all previous variables, morpho-syntactic added 10% of unique variance, while vocabulary did not add any significant variance.

Table 5.39 Regression analysis to investigate predictors of English word reading in Time 3

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	vocabulary	.334	.330	F(1,69)= 34.166 P= .000	.152	
	2	decoding	.787	.453	F(1,68)= 144.223 p= .000	.535	
II	1	decoding	.744	.740	F(1,69)= 199.423 p= .000		
	2	vocabulary	.787	.043	F(1,68)= 13.566 p= .000		
III	3	phonological processing	.792	.005	F(1,67)= 1.689 p= .198	rapid naming	- .091
	4	orthographic processing	.829	.037	F(2,65)= 7.071 p= .002	orthographic discrimination	.059
						word chain	.213
IV	3	orthographic processing	.822	.035	F(2,66)= 6.540 p= .003		
	4	phonological processing	.829	.007	F(1,65)= 2.717 p= .104		
	5	Morpho-syntactic awareness	.840	.011	F(2,63)= 2.072 p= .134	syntactic awareness	- .002
						morphological segmentation	.127

Table 5.40 Regression analysis to investigate predictors of English word reading in Time 3

		Variables	R^2	R^2 change	Sig R^2 change
1		decoding	.744	.740	F(1,69)= 199.423 p= .000
I	2	vocabulary	.787	.043	F(1,68)=13.566 p=.000
	3	orthographic processing	.822	.035	F(2,66)=6.540 p=.003
II	2	orthographic processing	.793	.049	F(2,67)=7.955 p=.001
	3	vocabulary	.808	.029	F(1,66)=10.654 p=.002

In Table 5.42, results show that after controlling for age and word reading, vocabulary explained 5% of variance in reading fluency, while it did not explain any variance at all when controlling for age, word reading and morpho-syntactic skills. Both orthographic and phonological skills explained unique variance in fluency, despite the changes in the entry order. Results also show that after controlling for age and word reading; morpho-syntactic awareness explained 23% of variance while orthographic processing explained 6% and phonological processing added an extra 2%. From this set of analyses, it could be concluded that the main predictors of Arabic Text Reading Fluency in Time 3 are word reading, morpho-syntactic awareness, orthographic processing and phonological awareness.

In the fourth set of analyses (see Table 5.43), English Text Reading Fluency was the dependent variable. Word reading, decoding, phonological processing, orthographic processing, vocabulary and morpho-syntactic awareness were the independent variables. The final beta scores show that the main predictor was word reading (beta score = .516). The data show that when controlling for age and word reading, decoding did not add any unique variance. When controlling for age, word and decoding, orthographic processing added 5% of unique variance while phonological processing was insignificant, even when the order of entry was reversed with orthographic processing. Both vocabulary and morpho-syntactic processing were insignificant when controlling for all the previous variables. Table 5.44 shows that when controlling for age, word reading and orthographic processing; morpho-syntactic awareness and vocabulary remained insignificant. From this set of analyses, it could be concluded that the main predictor of English text reading in Time 3 is word reading, in addition to orthographic processing.

<table>
<tr><td colspan="8">Table 5.41 Regression analysis to investigate predictors of Arabic Text Reading Fluency in Time 3</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>word reading</td><td>.325</td><td>.325</td><td>F(1,69)= 33.198
p=.000</td><td colspan="2">.203</td></tr>
<tr><td>2</td><td>decoding</td><td>.341</td><td>.016</td><td>F(1,68)=1.656
p=.203</td><td colspan="2">.101</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>decoding</td><td>.258</td><td>.258</td><td colspan="3">F(1,69)= 24.015
p=.000</td></tr>
<tr><td>2</td><td>word reading</td><td>.341</td><td>.083</td><td colspan="3">F(1,68)=8.533
p=.005</td></tr>
<tr><td rowspan="3">III</td><td>3</td><td>phonological awareness</td><td>.503</td><td>.162</td><td>F(1,67)=21.827
p=.000</td><td>rapid naming</td><td>- .178</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">orthographic processing</td><td rowspan="2">.552</td><td rowspan="2">.049</td><td rowspan="2">F(2,65)=3.531
p=.035</td><td>orthographic discrimination</td><td>.165</td></tr>
<tr><td>word chain</td><td>.166</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>orthographic processing</td><td>.461</td><td>.120</td><td colspan="3">F(2,66)=7.333
p=.001</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.552</td><td>.091</td><td colspan="3">F(1,65)=13.170
p=.001</td></tr>
<tr><td rowspan="3">V</td><td rowspan="2">5</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.648</td><td rowspan="2">.097</td><td rowspan="2">F(2,63)=8.655
p=.000</td><td>syntactic awareness</td><td>.396</td></tr>
<tr><td>morphological segmentation</td><td>.003</td></tr>
<tr><td>6</td><td>vocabulary</td><td>..649</td><td>.001</td><td>F(1,62)=.114
p=.737</td><td colspan="2">- .031</td></tr>
<tr><td rowspan="2">VI</td><td>5</td><td>vocabulary</td><td>.512</td><td>.009</td><td colspan="3">F(1,64)=1.242
p=.269</td></tr>
<tr><td>6</td><td>Morpho-syntactic awareness</td><td>.649</td><td>.089</td><td colspan="3">F(2,62)=7.836
p=.001</td></tr>
</table>

In the fifth set of analyses (see Table 5.45), Arabic word spelling was the dependent variable. The final beta scores show that the main predictor was morpho-syntactic awareness (beta score= .598). The data in Table 5.45 show that, when controlling for age, vocabulary explained 8.2% then decoding added an extra 23.6% of variance of Arabic word spelling. When decoding was before vocabulary, it explained 26.5% of variance while vocabulary explained only 5.3%. When controlling for age, decoding and vocabulary; then phonological awareness was entered before orthographic processing, it explained 9.2% while orthographic processing did not add unique variance. When the order was reversed, orthographic processing explained 8.8% of unique variability while phonological awareness explained 5% of variability. When controlling for all the previous variables, morpho-syntactic awareness explained 15.2% of Arabic word spelling variability. Table 5.46 shows that when controlling for age, morpho-syntactic awareness decoding and phonological processing; vocabulary and orthographic processing became insignificant. From this set of analyses, it could be concluded that the main predictor of Arabic word spelling in Time 3 is morpho-syntactic awareness in addition to decoding and phonological awareness.

Table 5.42 Regression analysis to investigate Time 3 predictors of Arabic Text Reading Fluency

		Variables	R^2	R^2 change	Sig R^2 change
1		word reading	.325	.325	F(1,69)= 33.198 p=.000
I	2	Morpho-syntactic awareness	.558	.233	F(2,67)=17.643 p=.000
	3	vocabulary	.558	.000	F(1,66)= .008 P=.930
II	2	vocabulary	.373	.049	F(1,68)=5.271 P=.025
	3	Morpho-syntactic awareness	.558	.184	F(2,66)=13.761 P=.000
III	4	Orthographic processing	.621	.063	F(2,64)=5.307 P=.007
	5	Phonological processing	.645	.024	F(1,63)=4.230 P=.044
IV	4	Phonological processing	.608	.050	F(1,65)=8.336 P=.005
	5	Orthographic processing	.645	.037	F(2,63)=3.236 P=.046
1		word reading	.325	.325	F(1,69)= 33.198 p=.000
2		Morpho-syntactic awareness	.558	.233	F(2,67)=17.643 p=.000
3		orthographic processing	.621	.063	F(2,65)=5.386 p=.007
4		phonological processing	.644	.023	F(1,64)=4.187 p=.045

Table 5.43 Regression analysis to investigate predictors of English Text Reading Fluency in Time 3

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	word reading	.776	.737	F(1,68)=224.103 p=.000	.516	
	2	decoding	.777	.000	F(1,67)=.114 p=.737	.002	
II	1	decoding	.596	.556	F(1,68)= 93.672 p= .000		
	2	word reading	.777	.181	F(1,67)=54.259 p=.000		
III	3	phonological awareness	.780	.003	F(1,66)=1.019 p=.317	rapid naming	- .071
	4	orthographic processing	.826	.046	F(2,64)=8.460 p=.001	orthographic discrimination	.148
						word chain	.230
IV	3	orthographic processing	.821	.044	F(2,65)=8.058 p=.001		
	4	phonological awareness	.826	.005	F(1,64)=1.844 p=.179		
V	5	Morpho-syntactic awareness	.839	.013	F(2,62)=2.520 p=.089	syntactic awareness	.024
						morphological segmentation	.137
	6	vocabulary	.839	.000	F(1,61)=.001 p=.981	.002	
VI	5	vocabulary	.826	.000	F(1,63)=.017 p=.896		
	6	Morpho-syntactic awareness	.816	.013	F(2,61)=2.471 p=.093		

Table 5.44 Regression analysis to investigate predictors of Time 3 English Text Reading Fluency

		Variables	R^2	R^2 change	Sig R^2 change
1		word reading	.776	.737	F(1,68)=224.103 p=.000
2		orthographic processing	.821	.045	F(2,66)=8.247 p=.001
I	3	Morpho-syntactic awareness	.836	.015	F(2,64)=2.870 p=.064
	4	vocabulary	.836	.000	F(1,63)=.045 p=.833
II	3	vocabulary	.822	.000	F(1,65)=.160 p=.691
	4	Morpho-syntactic awareness	.836	.014	F(2,63)=2.766 p=.071

<table>
<tr><td colspan="8">Table 5.45 Regression analysis to investigate predictors of Arabic word spelling in Time 3</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>vocabulary</td><td>.085</td><td>.082</td><td>F(1,69)= 6.200
P=.015</td><td colspan="2">- .063</td></tr>
<tr><td>2</td><td>decoding</td><td>.321</td><td>.236</td><td>F(1,68)= 23.655
p= .000</td><td colspan="2">.259</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>decoding</td><td>.268</td><td>.265</td><td colspan="3">F(1,69)= 24.963
p= .000</td></tr>
<tr><td>2</td><td>vocabulary</td><td>.321</td><td>.053</td><td colspan="3">F(1,68)= 5.354
p= .024</td></tr>
<tr><td rowspan="3">III</td><td>3</td><td>phonological awareness</td><td>.414</td><td>.092</td><td>F(1,67)= 10.574
p= .002</td><td>rapid naming</td><td>- .180</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">orthographic processing</td><td rowspan="2">.460</td><td rowspan="2">.046</td><td rowspan="2">F(2,65)= 2.750
p= .071</td><td>orthographic discrimination</td><td>.109</td></tr>
<tr><td>word chain</td><td>.025</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>orthographic processing</td><td>.410</td><td>.088</td><td colspan="3">F(2,66)= 4.942
p= .010</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.460</td><td>.050</td><td colspan="3">F(1,65)= 5.993
p= .017</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">5</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.612</td><td rowspan="2">.152</td><td rowspan="2">F(2,63)= 12.320
p= .000</td><td>syntactic awareness</td><td>.382</td></tr>
<tr><td>morphological segmentation</td><td>.216</td></tr>
</table>

Table 5.46 Regression analysis to investigate predictors of Arabic word spelling in Time 3				
	Variables	R^2	R^2 change	Sig R^2 change
1	Morpho-syntactic awareness	.494	.491	F(2,68)=32.947 p=.000
2	decoding	.568	.074	F(1,67)=11.510 p=.001
3	phonological processing	.597	.029	F(1,66)=4.782 p=.032
4	vocabulary	.602	.005	F(1,65)=.752 p=.389
5	orthographic processing	.612	.010	F(2,63)=.794 p=.456

In the sixth set of analyses (see Table 5.47), English word spelling was the dependent variable. The final beta scores show that the main predictor is morpho-syntactic awareness (beta score= .294). The data in the table show that when controlling for age, all the other variables added unique variance (in the order shown in the table). When added first, vocabulary explained 30% while decoding explained 21.4% variance of English word spelling. When decoding was entered first, it explained 43.7% of variance while vocabulary explained only 7.8%. After controlling for age, decoding and vocabulary, when phonological awareness was entered before orthographic processing, it explained 3.2% while orthographic processing explained 4.8%. When the order was reversed, orthographic processing explained 5.5% of unique variability while phonological awareness explained only 2.5% of variability. Morpho-syntactic awareness explained 4.6% of English word spelling variability. Table 7.48 shows that when controlling for age, decoding added 44% of variance of English word spelling. When controlling for age and decoding; morpho-syntactic awareness added 13% then vocabulary added more 3% of variance. When the order of vocabulary and morpho-syntactic awareness was reversed, vocabulary explained 8% of variance and then morpho-syntactic processing added 9% more. Both orthographic processing and phonological processing became insignificant. From this set of analyses, it could be concluded that the main predictors of English word spelling in Time 3 are mainly decoding, morpho-syntactic awareness and vocabulary.

In the seventh set of analyses (see Table 5.49 and 5.50), Arabic word decoding was the dependent variable. The independent variables were vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The data show that, when controlling for age, orthographic processing was the only significant variable and it explained 23% of variance. In Table 5.50 vocabulary was entered as the last step. However all variables remain insignificant and orthographic processing remains the main predictor, and it explained 26% of variance. Even, when phonological processing was entered as the first step, after age, it explained only 7% of variance in decoding while orthographic processing (which was entered as step two), explained 22% of unique variance, beyond that explained by phonological processing. Results from this set of analyses indicate that the main predictor of Arabic word decoding is mainly orthographic processing.

<table>
<tr><td colspan="7">Table 5.47 Regression analysis to investigate predictors of English word spelling in Time 3</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R²</td><td>R² change</td><td>Sig R² change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>vocabulary</td><td>.301</td><td>.301</td><td>F(1,69)= 29.689
P= .000</td><td colspan="2">.156</td></tr>
<tr><td>2</td><td>decoding</td><td>.515</td><td>.214</td><td>F(1,68)= 30.042
p= .000</td><td colspan="2">.266</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>decoding</td><td>.438</td><td>.437</td><td colspan="3">F(1,69)= 53.652
p= .000</td></tr>
<tr><td>2</td><td>vocabulary</td><td>.515</td><td>.078</td><td colspan="3">F(1,68)= 10.887
p= .002</td></tr>
<tr><td rowspan="3">III</td><td>3</td><td>phonological awareness</td><td>.547</td><td>.032</td><td>F(1,67)= 4.662
p= .034</td><td>rapid naming</td><td>- .119</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">orthographic processing</td><td rowspan="2">.595</td><td rowspan="2">.048</td><td rowspan="2">F(2,65)= 3.844
p= .026</td><td>orthographic discrimination</td><td>.160</td></tr>
<tr><td>word chain</td><td>.103</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>orthographic processing</td><td>.570</td><td>.055</td><td colspan="3">F(2,66)= 4.199
p= .019</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.595</td><td>.025</td><td colspan="3">F(1,65)= 3.971
p= .050</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">5</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.641</td><td rowspan="2">.046</td><td rowspan="2">F(2,63)= 4.064
p= .022</td><td>syntactic awareness</td><td>.286</td></tr>
<tr><td>morphological segmentation</td><td>.008</td></tr>
</table>

<table>
<tr><td colspan="6">Table 5.48 Regression analysis to investigate predictors of English word spelling in Time 3</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R²</td><td>R² change</td><td>Sig R² change</td></tr>
<tr><td colspan="2">1</td><td>decoding</td><td>.438</td><td>.437</td><td>F(1,69)= 53.652
p= .000</td></tr>
<tr><td rowspan="4">II</td><td>2</td><td>vocabulary</td><td>.515</td><td>.078</td><td>F(1,68)= 10.887
p= .002</td></tr>
<tr><td>3</td><td>Morpho-syntactic awareness</td><td>.602</td><td>.087</td><td>F(2,66)= 7.210
p=.001</td></tr>
<tr><td>2</td><td>Morpho-syntactic awareness</td><td>.568</td><td>.131</td><td>F(2,67)=10.143
P=.000</td></tr>
<tr><td>3</td><td>vocabulary</td><td>.602</td><td>.034</td><td>F(1,66)=5.614
P=.021</td></tr>
<tr><td colspan="2">4</td><td>orthographic processing</td><td>.632</td><td>.030</td><td>F(2,64)= 2.577
p=.084</td></tr>
<tr><td colspan="2">5</td><td>phonological awareness</td><td>.641</td><td>.009</td><td>F(1,63)= 1.618
p=.208</td></tr>
</table>

<table>
<tr><th colspan="7">Table 5.49 Regression analysis to investigate predictors of Arabic word decoding in Time 3</th></tr>
<tr><th colspan="2"></th><th>Variables</th><th>R^2</th><th>R^2 change</th><th>Sig R^2 change</th><th colspan="2">Final Beta</th></tr>
<tr><td></td><td>1</td><td>vocabulary</td><td>.031</td><td>.012</td><td>F(1,69)= .856
.358</td><td colspan="2">-.043-</td></tr>
<tr><td rowspan="3">I</td><td>3</td><td>phonological awareness</td><td>.050</td><td>.019</td><td>F(1,68)= 1.345
.250</td><td>rapid naming</td><td>-.028-</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">orthographic processing</td><td rowspan="2">.279</td><td rowspan="2">.229</td><td rowspan="2">F(2,66)=10.502
p=.000</td><td>orthographic discrimination</td><td>.125</td></tr>
<tr><td>word chain</td><td>.354</td></tr>
<tr><td rowspan="2">II</td><td>3</td><td>orthographic processing</td><td>.278</td><td>.247</td><td colspan="3">F(2,67)= 11.458
p=.000</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.279</td><td>.001</td><td colspan="3">F(1,66)=.113
p=.738</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">5</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.311</td><td rowspan="2">.032</td><td rowspan="2">F(2,64)=1.477
p=.236</td><td>syntactic awareness</td><td>.095</td></tr>
<tr><td>morphological segmentation</td><td>.170</td></tr>
</table>

<table>
<tr><th colspan="6">Table 5.50 Regression analysis to investigate predictors of Arabic word decoding in Time 3</th></tr>
<tr><th colspan="2">Arabic decoding</th><th>Variables</th><th>R^2</th><th>R^2 change</th><th>Sig R^2 change</th></tr>
<tr><td rowspan="2">I</td><td>1</td><td>orthographic processing</td><td>.275</td><td>.256</td><td>F(2,68)= 12.036
p=.000</td></tr>
<tr><td>2</td><td>phonological awareness</td><td>.278</td><td>.003</td><td>F(1,67)=.237
p=.628</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>phonological awareness</td><td>.090</td><td>.071</td><td>F(1,69)=5.412
P=.023</td></tr>
<tr><td>2</td><td>orthographic processing</td><td>.312</td><td>.222</td><td>F(2,67)=10.807
P=.000</td></tr>
<tr><td colspan="2">3</td><td>Morpho-syntactic awareness</td><td>.310</td><td>.032</td><td>F(2,65)= 1.493
p=.232</td></tr>
<tr><td colspan="2">4</td><td>vocabulary</td><td>.311</td><td>.001</td><td>F(1,64)=.117
p=.733</td></tr>
</table>

In the eighth set of analyses (see Table 5.51 and 5.52), English word decoding was the dependent variable. The independent variables were vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The data show that when controlling for age and entering vocabulary first, it explained 20.5% of variance, phonological processing explained 6%, orthographic explained 25.5%, and morpho-syntactic awareness explained 5%. When orthographic processing was entered before phonological processing, it explained 28% of variance while the latter explained only 4%. Table 5.52 shows that, when controlling for age, phonological processing explained 18% of variance, and then orthographic processing added 33 % of variance when entered after it. When orthographic processing was entered first, it explained 45% of variance and phonological processing explained 6%. When controlling for the previous variables; vocabulary became insignificant while morpho-syntactic processing explained 6% of variance. Results from this set of analyses indicate that the main predictors of English word decoding are orthographic processing, phonological processing, and morpho-syntactic processing.

Table 5.51 Regression analysis to investigate predictors of English word decoding in Time 3

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
	1	vocabulary	.209	.205	F(1,69)=17.905 p=.000	.072	
I	2	phonological processing	.269	.060	F(1,68)= 5.605 p=.021	rapid naming	-.131-
	3	orthographic processing	.524	.255	F(2,66)= 17.664 p=.000	orthographic discrimination	.009
						word chain	.461
II	2	orthographic processing	.487	.279	F(2,67)= 18.215 p=.000		
	3	phonological processing	.524	.036	F(1,66)= 5.048 p=.028		
	4	Morpho-syntactic awareness	.576	.053	F(2,64)= 3.965 p=.024	syntactic awareness	.230
						morphological segmentation	.114

Table 5.52 Regression analysis to investigate predictors of English word decoding in Time 3

Arabic decoding		Variables	R^2	R^2 change	Sig R^2 change
I	1	Phonological processing	.180	.176	F(1,69)= 14.818 p=.000
	2	orthographic processing	.511	.331	F(2,67)= 22.963 p=.000
II	1	orthographic processing	.449	.446	F(2,68)=27.552 p=.000
	2	Phonological processing	.511	.061	F(2,67)=8.411 p=.005
III	3	vocabulary	.524	.013	F(1,66)= 1.794 p=.185
	4	Morpho-syntactic processing	.576	.053	F(2,64)= 3.965 p=.024
IV	3	Morpho-syntactic processing	.573	.062	F(2,65)=4.718 P=.012
	4	vocabulary	.576	.003	F(1,64)=.520 P=.473

Path Analyses

Arabic Word Reading Model

Based on the regression results, the initial hypothesised model included paths from orthographic processing variables to word decoding (which was used as a mediator in the model). Then from all exogenous Time 3 variables, in addition to decoding to Word Reading. Age was controlled for as discussed before. The initial model provided a good fit to the data set: $\chi 2$ (4) = 3.059, p=.548, CFI=1.000, RMSEA=.000, PCLOSE=.629. To build a simpler model, we deleted insignificant paths as discussed before. The final model provided a good fit: $\chi 2$ (10) = 14.951, p=.134, CFI=.970, RMSEA=.084, PCLOSE=.239. The final model shows that decoding and word chain are directly related to Arabic Word reading (see Figure 5.9).

English Word Reading Model

Based on the regression results, the initial hypothesised model included paths from orthographic processing and morpho-syntactic processing variables to word decoding (which was used as a mediator in the model). Then from all exogenous Time 3 variables, in addition to decoding to Word Reading. Age was controlled for as discussed before. The initial model provided a good fit to the data set: $\chi 2$ (2) = 2.912, p=.233, CFI=.996, RMSEA=.081, PCLOSE=.291. To build a simpler model, we deleted insignificant paths as discussed before. The final model provided a good fit: $\chi 2$ (7) = 8.654, p=.278, CFI=.993 RMSEA=.058, PCLOSE=.393. The model shows that decoding, vocabulary, morphological segmentation and word chain are directly related to English word reading while both syntactic awareness and word chain are indirectly related to it via decoding (see Figure 5.10).

Arabic Text Reading Fluency Model

Based on the regression results, the initial hypothesised model included paths from orthographic processing variables to word decoding (which was used as a mediator in the model). Then from all exogenous Time 3 variables, in addition to decoding to Word Reading. Age was controlled for as discussed before. The initial model provided a good fit to the data set: $\chi 2$ (10) = 14.951, p=.134, CFI=.978, RMSEA=.084, PCLOSE=.239. To build a simpler model, we deleted insignificant paths as discussed before. The final model provided a good fit: $\chi 2$ (13) = 16.007, p=.249, CFI=.987, RMSEA=.057, PCLOSE=.402. The final model shows that word reading, RAN, orthographic discrimination, word chain and syntactic awareness are directly related to Arabic Text Reading Fluency. It also shows that decoding and word chain are indirectly related to it via word reading word reading (see Figure 5.11).

English Text Reading Fluency Model

Based on the English Word Reading Model (see figure 5.10), the initial hypothesised model included paths from word chain and syntactic awareness to decoding (which was used as a mediator in the model), and from decoding, word chain, vocabulary and morphological segmentation to word reading (which was also used as a mediator in the model). Then from all exogenous Time 3 variables, in addition to Decoding and Word Reading to English Text Reading Fluency. Age was controlled for as discussed before. The initial model provided a good fit to the data set: $\chi 2$ (7) = 8.654, p=.278, CFI=.996, RMSEA=.058, PCLOSE=.393. To build a simpler model, we deleted insignificant paths as discussed before. The final model provided a good fit: $\chi 2$ (11) = 11.023, p=.441, CFI=1.000 RMSEA=.005, PCLOSE=.589. The model shows that word reading, orthographic discrimination, word chain and morphological segmentation and are directly related to English Text Reading Fluency. It also shows that decoding, morphological segmentation, vocabulary and word chain are indirectly related to it via decoding. Syntactic awareness has an indirect path via decoding which in turn has a path to word reading (see Figure 5.12).

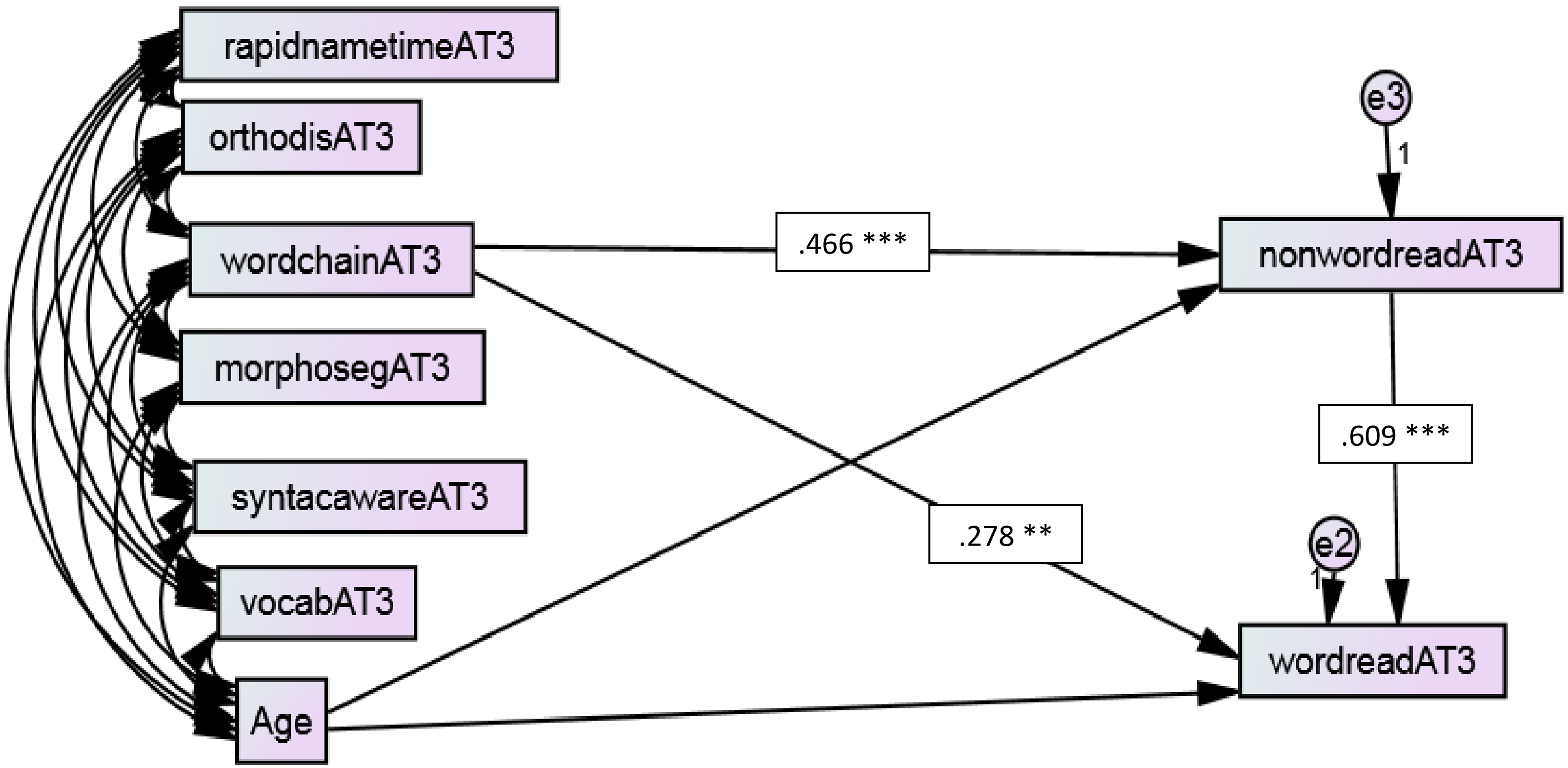
Arabic Word Spelling Model

Based on the regression results, the initial hypothesised model included paths from orthographic processing variables to word decoding (which was used as a mediator in the model). Then from all exogenous Time 3 variables, in addition to decoding to Word Reading. Age was controlled for as discussed before. The initial model provided a good fit to the data set: $\chi 2$ (4) = 3.059, p=.548, CFI=1.000, RMSEA=.000, PCLOSE=.629. To build a simpler model, we deleted insignificant paths as discussed before. The final model provided a good fit: $\chi 2$ (8) = 9.464, p=.305, CFI=.991, RMSEA=.051, PCLOSE=.430. The final model shows that decoding, RAN, and morpho-syntactic skills are directly related to Arabic Word Spelling. It also shows that word chain is indirectly related to word spelling via decoding (see Figure 5.13).

English Word Spelling Model

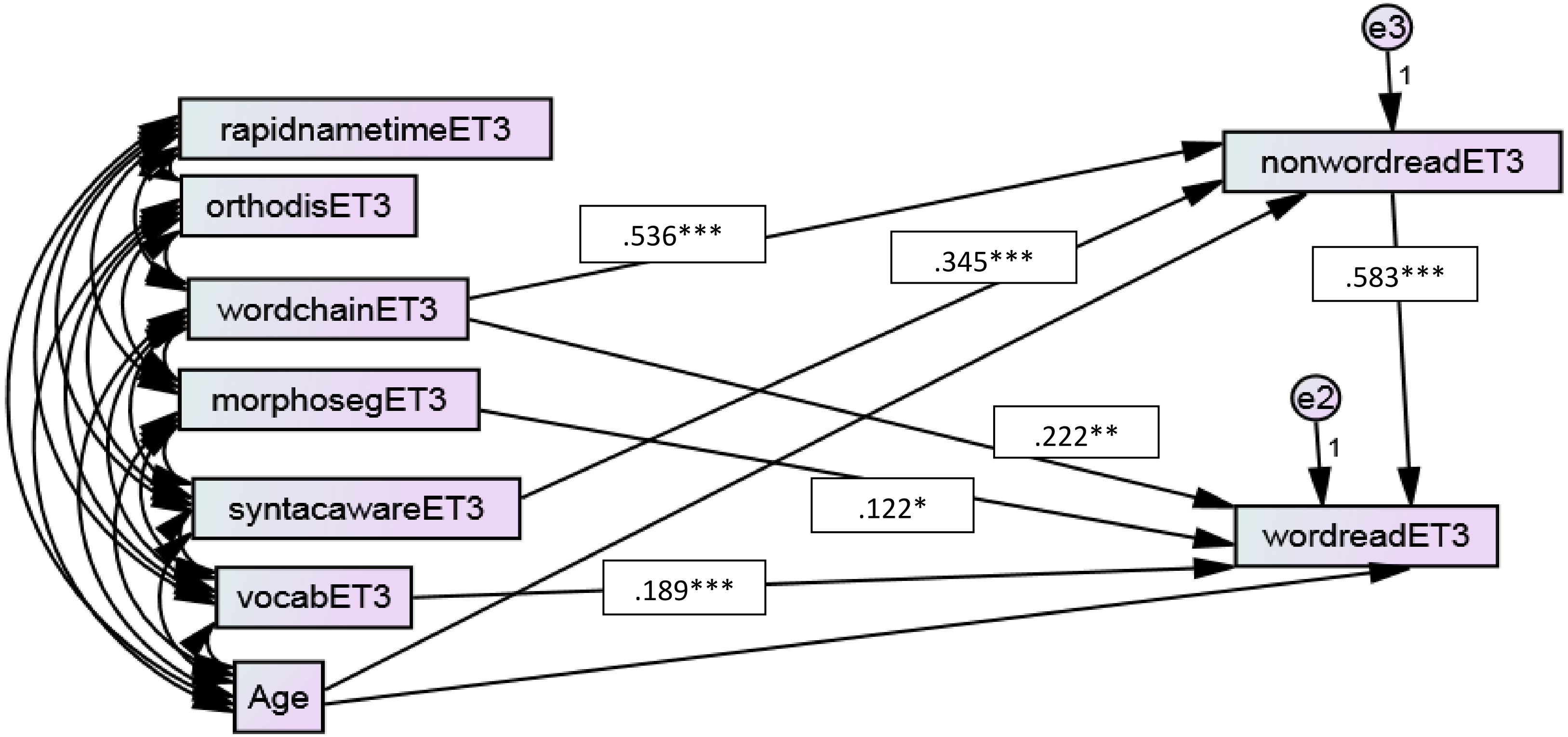
Based on the regression results, the initial hypothesised model included paths from orthographic processing and morpho-syntactic processing variables to word decoding (which was used as a mediator in the model). Then paths were added from all exogenous Time 3 variables, in addition to decoding to Word Reading. Age was controlled for as discussed before. The initial model provided a good fit to the data set: $\chi 2$ (2) = 2.912, p=.233, CFI=.995, RMSEA=.081, PCLOSE=.291. To build a simpler model, we deleted insignificant paths as discussed before. The final model provided a good fit: $\chi 2$ (7) = 7.316, p=.397, CFI=.998 RMSEA=.025, PCLOSE=.516. The model shows that decoding, vocabulary, syntactic awareness and orthographic discrimination are directly related to English word spelling. It also shows that both syntactic awareness and word chain are indirectly related to it via decoding (see Figure 5.14).

Figure 5.9 Path diagram to show the concurrent relations between variables from Time 3 to Time 3 Arabic Word Reading



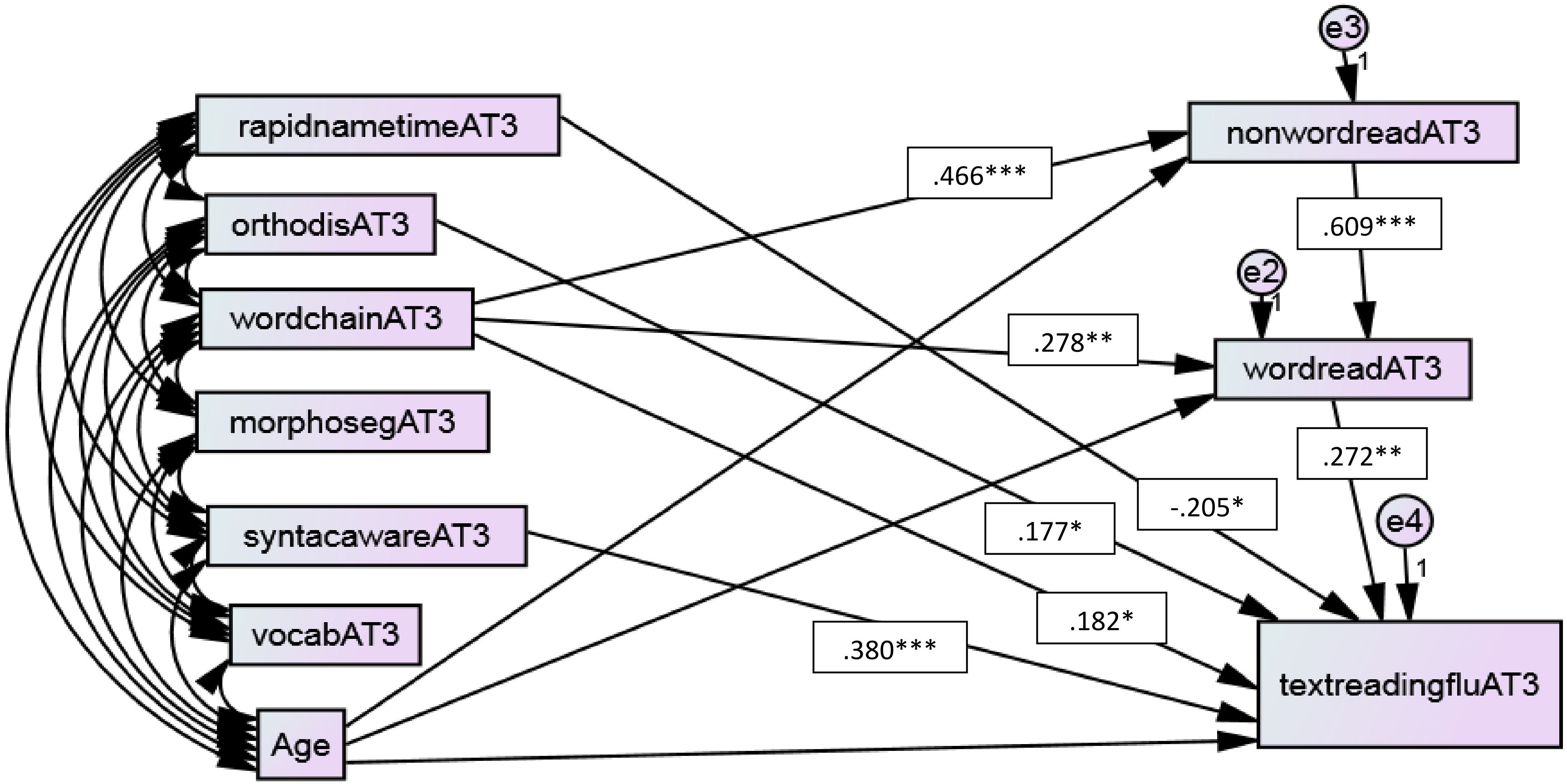
Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$

Figure 5.10 Path diagram to show the concurrent relations between variables from Time 3 to Time 3 English Word Reading



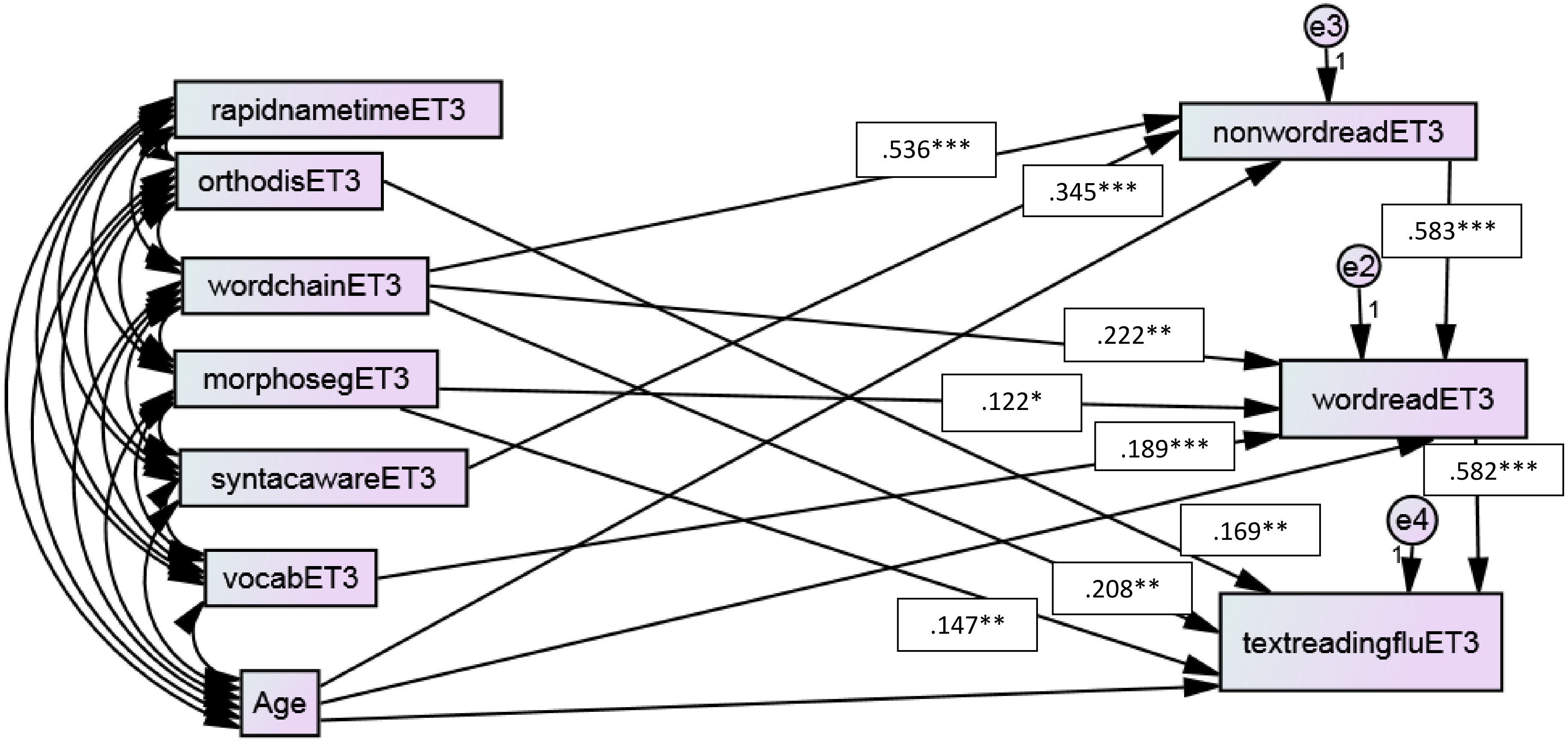
Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$

Figure 5.11 Path diagram to show the concurrent relations between variables from Time 3 to Time 3 Arabic Text Reading Fluency



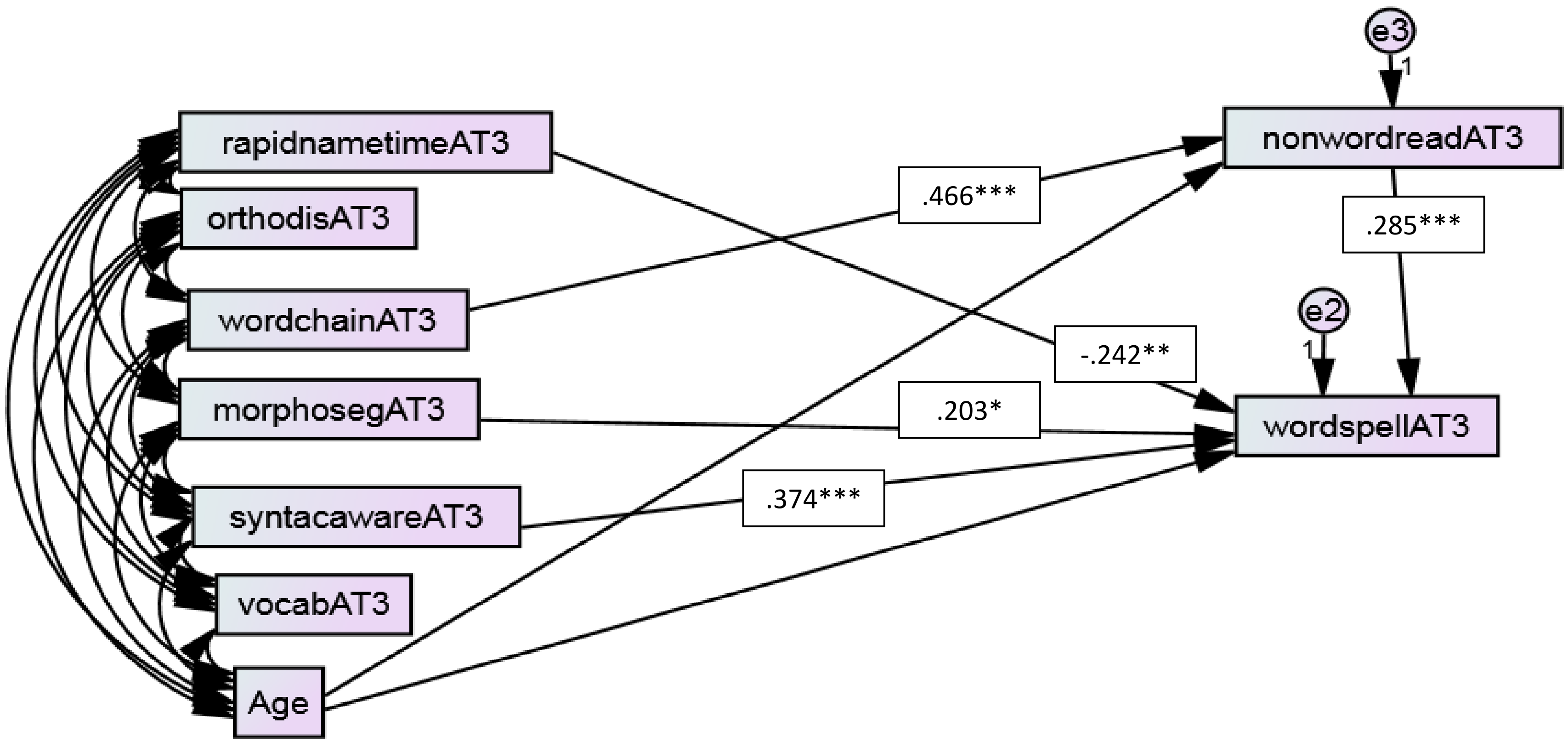
Note. Numbers in the figure are standardised regression weights. *p=.05. **p=.01.***p < .001

Figure 5.12 Path diagram to show the concurrent relations between variables from Time 3 to Time 3 English Text Reading Fluency



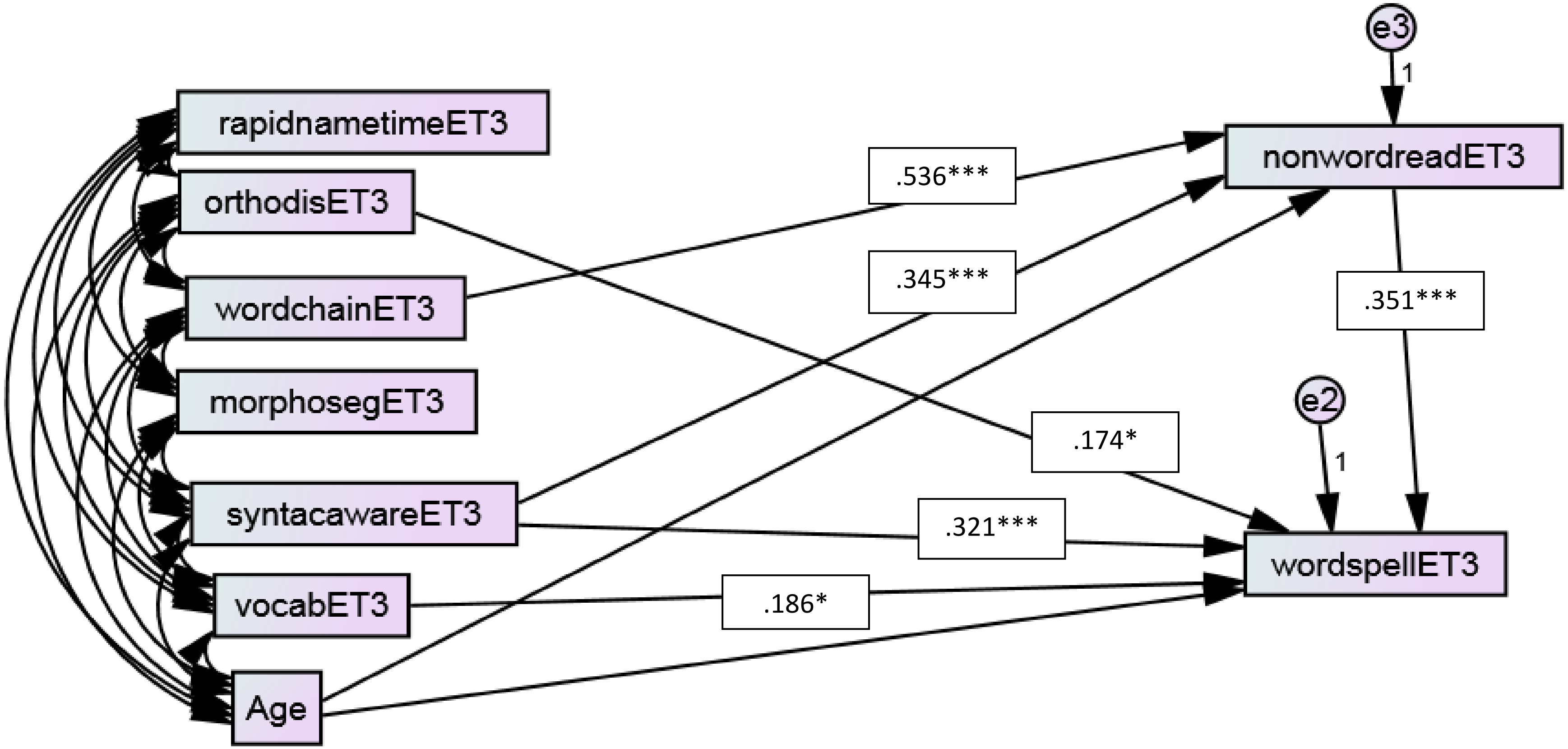
Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$

Figure 5.13 Path diagram to show the concurrent relations between variables from Time 3 to Time 3 Arabic Word Spelling



Note. Numbers in the figure are standardised regression weights. ∗*p*=.05. ∗∗*p*=.01.∗∗∗*p* < .001

Figure 5.14 Path diagram to show the concurrent relations between variables from Time 3 to Time 3 English Word Spelling



Note. Numbers in the figure are standardised regression weights. $*p=.05$. $**p=.01$.$***p < .001$

Time 4

Table 5.53 demonstrates the descriptive data analysis of Time 4 for Arabic and English measures and the non-language measure. The table shows the means, standard deviations (in round brackets), minimum-maximum scores, and maximum possible scores (in square brackets). Tables 5.45 and 5.55 demonstrate correlations within Time 4 for Arabic and English measures (respectively) and the non-language measures. Table 5.56 demonstrates correlations across languages in Time 4.

Table 5.53. Descriptive data analysis at Time 4, Means, with standard deviations in round brackets, minimum-maximum scores, and the maximum possible scores in square brackets, for the measures in the Study for Arabic and English measures and the non-language measure

	Arabic	**English**
Text Comprehension Marked	14.68 (5.27) 5-25 [27]	12.15 (5.62) 3-27 [27]
Text Comprehension Non-Marked	17.85 (5.71) 5-27 [27]	
Comprehension Fluency	18.73 (9.49) 1-42 [50]	8.34 (4.50) 1-19 [50]
Text Spelling	49.18 (20.82) 4-76 [77]	24.87 (14.45) 0-58 [63]
Composition Coherence	6.63 (2.47) 0-10 [10]	4.70 (3.49) 0-10 [10]
Composition Correct Words	21.99 (11.18) 2-60	13.31 (9.78) 0-34
Non-Word Reading	14.25 (5.78) 0-24 [25]	10.39 (5.78) 0-22 [25]
Word Chain	9.34 (7.07) 0-20 [20]	8.34 (6.27) 0-20 [20]
Sound Deletion	19.39 (6.45) 1-30 [30]	17.70 (6.61) 0-28 [30]

Table 5.54 Correlations within Time 4 for Arabic measures and the non-language measures.

Arabic T4	text comprehension non-marked	text comprehension marked	comprehension fluency	text spelling	composition coherence	non word reading	Sound Deletion
text comprehension marked	.643**						
comprehension fluency	.545**	.458**					
text spelling	.689**	.645**	.618**				
composition coherence	.422**	.402**	.421**	.589**			
non word reading	.702**	.595**	.620**	.784**	.472**		
sound deletion	.669**	.578**	.509**	.785**	.467**	.777**	
word chain	.710**	.595**	.476**	.538**	.231	.680**	.542**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Table 5.55 Correlations within Time 4 for English measures and the non-language measures.

English T4	text comprehension	comprehension fluency	text spelling	composition coherence	non word reading	Sound Deletion
comprehension fluency	.464**					
text spelling	.670**	.518**				
composition coherence	.624**	.485**	.856**			
non word reading	.570**	.340**	.803**	.660**		
sound deletion	.521**	.319**	.605**	.549**	.701**	
word chain	.665**	.544**	.762**	.708**	.731**	.553**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Table 5.56 Correlations across languages in Time 4

Arabic / English	text comprehension non-marked	text comprehension marked	comprehension fluency	text spelling	composition coherence	non word reading	sound deletion	word chain
text comprehension	.573**	.526**	.377**	.406**	.271*	.502**	.475**	.476**
comprehension fluency	.303*	.374**	.364**	.345**	.415**	.326**	.270*	.396**
text spelling	.677**	.572**	.521**	.733**	.486**	.640**	.584**	.532**
composition coherence	.539**	.535**	.502**	.669**	.528**	.546**	.538**	.368**
non word reading	.700**	.566**	.484**	.723**	.431**	.760**	.690**	.553**
sound deletion	.646**	.568**	.442**	.657**	.501**	.700**	.753**	.538**
word chain	.601**	.556**	.471**	.543**	.407**	.637**	.529**	.691**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

From Table 5.53, it appears that all skills in Arabic are higher than their counterparts in English. Table 5.54 shows the correlations within Time 4 for Arabic measures and the non-language measures. The table shows that Arabic reading comprehension skills (marked text comprehension, non-marked text comprehension, and comprehension fluency) correlated with decoding (non-word reading), phonological awareness (sound deletion) and orthographic processing (word chain). Arabic composition skills (number of correctly spelt words and composition coherence) and Arabic text spelling similarly correlated with decoding (non-word reading), phonological awareness (sound deletion) and orthographic processing (except for composition coherence that did not correlate with word chain).

Table 5.55 shows the correlations within Time 4 for English measures and the non-language measures. The table shows that English reading comprehension skills (text comprehension and comprehension fluency) correlated with decoding (non-word reading); phonological awareness (sound deletion) and orthographic processing (word chain). English composition skills (number of correctly spelt words and composition coherence) and English text spelling, similarly correlated with decoding (non-word reading), phonological awareness (sound deletion) and orthographic processing.

Table 5.56 shows correlations across languages in Time 4. It is clear from the table that all skills in Arabic were correlated with their counterparts in English. The table also shows that Arabic comprehension, composition, and spelling skills correlated with English, non-word reading, sound deletion, and word chain. It also shows that English comprehension, composition, and spelling skills correlated with Arabic, non-word reading, sound deletion, and word chain.

Regression analyses were performed to investigate variance by each measure in Time 4. The dependent variables were Arabic marked comprehension, Arabic non-marked comprehension, English reading comprehension, Arabic comprehension fluency, English comprehension fluency, Arabic text spelling, English text spelling, Arabic composition coherence, English composition coherence, Arabic composition correctly spelt words and English composition correctly spelt words. For each set of analysis, the independent variables were decoding skills (non-word reading), phonological processing (sound deletion), and orthographic processing (word chain) (unless stated differently). The independent variables were entered in a set order as discussed at the beginning of the chapter.

In the first set of analyses (see Table 5.57), Arabic marked text comprehension was the dependent variable. The final beta scores show that the main predictor was word chain (beta score = .340). The data in Table 5.57 show that when controlling for age, decoding explained 35.3% variance of Arabic marked text comprehension. When controlling for age and decoding, then phonological awareness was entered before orthographic processing (see Analysis I), it explained 3.1 % while orthographic processing explained 6.2%. When the order was reversed (see Analysis II), orthographic processing explained 6.4% of unique variability while phonological awareness explained 2.9%. Analysis III shows that when controlling for age, orthographic processing, and phonological awareness, decoding did not add unique variance. It could be concluded from this of analysis that the main predictor of Arabic Marked-Text Comprehension is decoding with some orthographic processing.

<table>
<tr><td colspan="8">Table 5.57 Regression analysis to investigate predictors of Arabic marked text comprehension in Time 4</td></tr>
<tr><td></td><td></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td></td><td>1</td><td>decoding</td><td>.365</td><td>.353</td><td>F(1,68)= 37.882 p=.000</td><td>non-word reading</td><td>.152</td></tr>
<tr><td rowspan="2">I</td><td>2</td><td>phonological awareness</td><td>.397</td><td>.031</td><td>F(1,76)= 3.486 p= .066</td><td>sound deletion</td><td>.271</td></tr>
<tr><td>3</td><td>orthographic processing</td><td>.459</td><td>.062</td><td>F(1,66)= 7.554 p= .008</td><td>word chain</td><td>.340</td></tr>
<tr><td rowspan="2">II</td><td>2</td><td>orthographic processing</td><td>.430</td><td>.064</td><td colspan="3">F(1,67)= 7.547 p= .008</td></tr>
<tr><td>3</td><td>phonological awareness</td><td>.459</td><td>.029</td><td colspan="3">F(1,66)= 3.548 p= .064</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td rowspan="3">III</td><td>1</td><td>orthographic processing</td><td>.360</td><td>.348</td><td colspan="3">F(1,68)=37.046 p=.000</td></tr>
<tr><td>2</td><td>phonological awareness</td><td>.452</td><td>.091</td><td colspan="3">F(1,67)=11.171 p=.001</td></tr>
<tr><td>3</td><td>decoding</td><td>.459</td><td>.007</td><td colspan="3">F(1,66)=.851 p=.360</td></tr>
</table>

In the second set of analyses (see Table 5.58), Arabic non-marked text comprehension was the dependent variable. The final beta scores show that the main predictor was word chain (beta score = .424). The data in Table 5.42 show that when controlling for age, decoding explained 49.2% variance of Arabic non-marked text comprehension. When controlling for age and decoding, then phonological awareness was entered before orthographic processing (see Analysis I), it explained 3.7 % while orthographic processing explained 9.6%. When the order was reversed (see Analysis II), orthographic processing explained 9.9% of unique variability while phonological awareness explained 3.4%. When controlling for age, orthographic processing, and phonological awareness (see Analysis III), decoding did not add any unique variance. From this set of analysis, it could be concluded that the main predictors of Arabic non-marked text comprehension are orthographic processing and phonological awareness.

In the third set of analyses (see Table 5.59), English text comprehension was the dependent variable. The final beta scores show that the main predictor was word chain (beta score = .538). The data in Table 5.59 show that when controlling for age, decoding explained 31.5% variance of English text comprehension. When controlling for age and decoding, then phonological awareness was entered before orthographic processing, it explained 3.2 % while orthographic processing explained 13.2%. When the order was reversed, orthographic processing explained 14.1% of unique variability while phonological awareness explained 2.3%.When controlling for age, orthographic processing, and phonological awareness (see Analysis III), decoding did not add any unique variance. It could be concluded from this analysis that the main predictor of English text comprehension is orthographic processing, in addition to phonological awareness.

In the fourth set of analyses (see Table 5.60), Arabic comprehension fluency was the dependent variable. The final beta scores show that the main predictor was decoding (beta score = .496). The data in Table 5.60 show that, when controlling for age decoding explained 38.4% variance of Arabic comprehension fluency. When controlling for age and decoding, both phonological awareness and orthographic processing become insignificant. It could be concluded then that the main predictor of Arabic comprehension fluency is decoding, even when their order of entry is reversed.

Table 5.58 Regression analysis to investigate predictors of Arabic non-marked text comprehension in Time 4

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
	1	decoding	.496	.492	F(1,68)= 66.287 p= .000	non-word reading	.184
I	2	phonological awareness	.533	.037	F(1,67)=5.374 p=.023	sound deletion	.295
	3	orthographic processing	.629	.096	F(1,66)=17.079 p=.000	word chain	.424
II	2	orthographic processing	.595	.099	F(1,67)=16.383 p=.000		
	3	phonological awareness	.629	.034	F(1,66)= 6.111 p=.016		
III	1	orthographic processing	.505	.501	F(1,68)=68.814 p=.000		
	2	phonological awareness	.619	.114	F(1,67)=20.030 p=.000		
	3	decoding	.629	.010	F(1,66)=1.813 p=.183		

Table 5.59 Regression analysis to investigate predictors of English comprehension in Time 4

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
	1	decoding	.330	.315	F(1,68)=31.970 p=.000	non-word reading	.013
I	2	phonological awareness	.362	.032	F(1,67)= 3.354 p=.071	sound deletion	.216
	3	orthographic processing	.494	.132	F(1,66)=17.222 p=.000	word chain	.538
II	2	orthographic processing	.471	.141	F(1,67)=17.806 p=.000		
	3	phonological awareness	.494	.023	F(1,66)=3.040 p=.086		
III	1	orthographic processing	.460	.445	F(1,68)=.56.015 p=.000		
	2	phonological awareness	.494	.034	F(1,67)=4.504 p=.038		
	3	decoding	.494	.000	F(1,66)=.007 p=.932		

Table 5.60 Regression analysis to investigate predictors of Arabic comprehension fluency in Time 4

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
	1	decoding	.385	.384	F(1,68)=42.498 p=.000	non-word reading	.496
I	2	phonological awareness	.387	.002	F(1,67)=.221 p=.640	sound deletion	.068
	3	orthographic processing	.390	.006	F(1,66)=.631 p=.430	word chain	.104
II	2	orthographic processing	.391	.006	F(1,67)=.659 p=.420		
	3	phonological awareness	.393	.002	F(1,66)=.201 p=.655		

In the fifth set of analyses (see Table 5.61), English comprehension fluency was the dependent variable. The final beta scores show that the main predictor was word chain (beta score = .644). The data in Table 5.45 show that, when controlling for age, decoding explained 11.2% variance of English text comprehension. When controlling for both age and decoding, then phonological awareness explained 1.4 % while orthographic processing was insignificant, even after reversing the order of entry with phonological awareness (see Analyses I and II). When controlling for age and orthographic processing, decoding did not add any unique variance (see Analysis III).

It could be concluded that the main predictor of English comprehension fluency is orthographic processing.

<table>
<tr><td colspan="8">Table 5.61 Regression analysis to investigate predictors of English Comprehension Fluency in Time 4</td></tr>
<tr><td></td><td></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td></td><td>1</td><td>decoding</td><td>.117</td><td>.112</td><td>F(1,68)=8.636
p=.004</td><td>non-word reading</td><td>- .227</td></tr>
<tr><td rowspan="2">I</td><td>2</td><td>phonological awareness</td><td>.131</td><td>.014</td><td>F(1,67)=1.076
p=.303</td><td>sound deletion</td><td>.123</td></tr>
<tr><td>3</td><td>orthographic processing</td><td>.320</td><td>.189</td><td>F(1,66)=18.341
p=.000</td><td>word chain</td><td>.644</td></tr>
<tr><td rowspan="2">II</td><td>2</td><td>orthographic processing</td><td>.312</td><td>.195</td><td colspan="3">F(1,67)=19.032
p=.000</td></tr>
<tr><td>3</td><td>phonological awareness</td><td>.320</td><td>.008</td><td colspan="3">F(1,66)=.738
p=.393</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td rowspan="2">III</td><td>1</td><td>orthographic processing</td><td>.303</td><td>.298</td><td colspan="3">F(1,68)=29.031
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.312</td><td>.010</td><td colspan="3">F(1,67)=.949
p=.333</td></tr>
</table>

In the sixth set of analyses (see Table 5.62), Arabic text spelling was the dependent variable. The final beta scores show that the main predictor was sound deletion (beta score = .443), followed by word chain (beta score = .441). The data in Table 5.62 show that, when controlling for age, decoding explained 62% variance of Arabic text spelling. When controlling for both age and decoding, and phonological awareness was entered before orthographic processing, it explained 8% while orthographic processing explained no variability at all (Analysis I). When the order was reversed (Analysis II), orthographic processing still explained no variability at all while phonological awareness remained to explain 8%. When controlling for age and orthographic processing (Analysis III); decoding still added 8% of unique variance. It could be concluded that the main predictors of Arabic text spelling are decoding and phonological awareness.

In the seventh set of analyses (see Table 5.63), English text spelling was the dependent variable. The final beta scores show that the main predictor was decoding (beta score = .497), followed by word chain (beta score = .370). The data in Table 5.63 show that, when controlling for age, decoding explained 67.6% variance of English text spelling. When, when controlling for age and decoding, and phonological awareness was entered before orthographic processing, it was insignificant while orthographic processing explained 6.2%. When the order was reversed, orthographic processing explained 6.4% of unique variability while phonological awareness was insignificant. It could be concluded then that the predictors of English text spelling are decoding and orthographic processing.

Table 5.62 Regression analysis to investigate predictors of Arabic text spelling in Time 4

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
	1	decoding	.615	.615	F(1,68)=108.788 p=.000	non-word reading	.441
I	2	phonological awareness	.693	.077	F(1,67)=16.900 p=.000	sound deletion	.443
	3	orthographic processing	.693	.000	F(1,66)=.000 p=.991	word chain	- .001
II	2	orthographic processing	.615	.000	F(1,67)=.007 p=.932		
	3	phonological awareness	.693	.077	F(1,66)=16.639 p=.000		
III	1	phonological processing	.616	.616	F(1,68)=109.142 p=.000		
	2	decoding	.693	.077	F(1,67)=16.732 p=.000		

Table 5.63 Regression analysis to investigate predictors of English text spelling in Time 4

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
	1	decoding	.647	.646	F(1,68)=124.570 p=.000	non-word reading	.497
I	2	phonological awareness	.650	.003	F(1,67)=.580 p=.449	sound deletion	.053
	3	orthographic processing	.712	.062	F(1,66)=14.286 p=.000	word chain	.370
II	2	orthographic processing	.711	.064	F(1,67)=14.812 p=.000		
	3	phonological awareness	.712	.001	F(1,66)=.320 p=.574		

In the eighth set of analyses (see Table 5.64), Arabic composition coherence was the dependent variable. The final beta scores show that the main predictor was decoding (beta score = .381). The data in Table 5.64 show that, when controlling for age, decoding explained 22.3% variance of Arabic composition coherence. When controlling for age and decoding, neither phonological awareness nor orthographic processing added any unique variance, even when their order of entry was reversed. The conclusion here is that decoding is the main predictor of Arabic composition coherence.

<table>
<tr><td colspan="8">Table 5.64 Regression analysis to investigate predictors of Arabic composition coherence in Time 4</td></tr>
<tr><td></td><td></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td></td><td>1</td><td>decoding</td><td>.229</td><td>.223</td><td>F(1,68)=19.723
p=.000</td><td>non-word reading</td><td>.381</td></tr>
<tr><td rowspan="2">I</td><td>2</td><td>phonological awareness</td><td>.256</td><td>.027</td><td>F(1,67)=2.407
p=.125</td><td>sound deletion</td><td>.265</td></tr>
<tr><td>3</td><td>orthographic processing</td><td>.271</td><td>.015</td><td>F(1,66)=1.364
p=.247</td><td>word chain</td><td>- .168</td></tr>
<tr><td rowspan="2">II</td><td>2</td><td>orthographic processing</td><td>.243</td><td>.014</td><td colspan="3">F(1,67)=1.242
p=.269</td></tr>
<tr><td>3</td><td>phonological awareness</td><td>.271</td><td>.028</td><td colspan="3">F(1,66)=2.515
p=.118</td></tr>
</table>

In the ninth set of analyses (see Table 5.65), English composition coherence was the dependent variable. The final beta scores show that the main predictor was word chain (beta score = .473). The data in Table 5.65 show that, when controlling for age, decoding explained 44% variance of English composition coherence. When controlling for both age and decoding, and phonological awareness was entered before orthographic processing, it was insignificant while orthographic processing explained 10.2%. When the order was reversed, orthographic processing explained 10.6% of unique variability while phonological awareness was insignificant. When controlling for both age and orthographic processing (see Analysis III), decoding still added 4% of unique variance. The conclusion from this analysis is the predictors of English composition coherence are orthographic processing and decoding.

<table>
<tr><td colspan="8">Table 5.65 Regression analysis to investigate predictors of English composition coherence in Time 4</td></tr>
<tr><td></td><td></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td></td><td>1</td><td>decoding</td><td>.440</td><td>.440</td><td>F(1,68)=53.512
p=.000</td><td>non-word reading</td><td>.225</td></tr>
<tr><td rowspan="2">I</td><td>2</td><td>phonological awareness</td><td>.454</td><td>.013</td><td>F(1,67)=1.625
p=.207</td><td>sound deletion</td><td>.131</td></tr>
<tr><td>3</td><td>orthographic processing</td><td>.555</td><td>.102</td><td>F(1,66)=15.109
p=.000</td><td>word chain</td><td>.473</td></tr>
<tr><td rowspan="2">II</td><td>2</td><td>orthographic processing</td><td>.547</td><td>.106</td><td colspan="3">F(1,67)=15.747
p=.000</td></tr>
<tr><td>3</td><td>phonological awareness</td><td>.555</td><td>.009</td><td colspan="3">F(1,66)=1.266
p=.265</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td rowspan="2">III</td><td>1</td><td>orthographic processing</td><td>.503</td><td>.503</td><td colspan="3">F(1,68)=68.885
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.547</td><td>.044</td><td colspan="3">F(1,67)=6.454
p=.013</td></tr>
</table>

In the tenth set of analysis, (see Table 5.66), Arabic word decoding was the dependent variable. The independent variables were phonological processing and orthographic processing. The independent variables were entered in a set order. The data in Table 7.66 show that, when controlling for age, phonological awareness explained 60 % variance of Arabic word decoding while orthographic processing explained 46% of variance. When orthographic processing was entered after age, and phonological awareness, as the last step, it explained 10% of variance. When the order was reversed, phonological awareness explained 24% variability. Results from this set of analyses indicate that both orthographic processing and phonological awareness are predictors of Arabic word decoding.

<table>
<tr><th colspan="8">Table 5.66 Regression analysis to investigate predictors of Arabic word decoding in Time 4</th></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>phonological awareness</td><td>.604</td><td>.604</td><td>F(1,68)=103.907 p=.000</td><td>sound deletion</td><td>.071</td></tr>
<tr><td>2</td><td>orthographic processing</td><td>.700</td><td>.095</td><td>F(1,67)= 21.296 p=.000</td><td>word chain</td><td>.065</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>orthographic processing</td><td>.463</td><td>.463</td><td colspan="3">F(1,68)= 58.631 p=.000</td></tr>
<tr><td>2</td><td>phonological awareness</td><td>.700</td><td>.237</td><td colspan="3">F(1,67)= 52.866 p=.000</td></tr>
</table>

In the eleventh set of analysis, (see Table 5.67), English word decoding was the dependent variable. The independent variables were phonological processing and orthographic processing. Data entry process was similar to Arabic decoding analysis explained above. The data in Table 5.67 show that when controlling for age and phonological awareness was entered first; it explained 49 % variance of English word decoding while orthographic processing explained 17% of variance. When orthographic processing was entered first, it explained 45% of variance while phonological awareness explained 13% variability. Results from this set of analyses indicate that both orthographic processing and phonological awareness are predictors of English word decoding.

<table>
<tr><th colspan="8">Table 5.67 Regression analysis to investigate predictors of English word decoding in Time 4</th></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>phonological awareness</td><td>.501</td><td>.492</td><td>F(1,68)= 67.139 p=.000</td><td>sound deletion</td><td>.427</td></tr>
<tr><td>2</td><td>orthographic processing</td><td>.673</td><td>.171</td><td>F(1,67)= 35.083 p=.000</td><td>word chain</td><td>.497</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>orthographic processing</td><td>.546</td><td>.537</td><td colspan="3">F(1,68)= 80.437 p=.000</td></tr>
<tr><td>2</td><td>phonological awareness</td><td>.673</td><td>.127</td><td colspan="3">F(1,67)= 25.938 p=.000</td></tr>
</table>

Path Analyses

Arabic Marked-Text Comprehension Model

When trying to build a model, it did not provide a good fit even after deleting insignificant paths: $\chi 2$ (3) = 6.275, p=.099, CFI=.988, RMSEA=.125, PCLOSE=.148. When trying to build another model after covarying decoding with the other exogenous variables, again the fit was not acceptable: $\chi 2$ (1) = 1.911, p=.167, CFI=.993, RMSEA=.114, PCLOSE=.203 (Note the only path that was not significant in both models was the path from decoding to Marked-Text Comprehension).

Arabic Non-Marked-Text Comprehension Model

When trying to build a model, it did not provide a good fit: $\chi 2$ (the model was saturated and probability could not be completed), CFI=1.000, RMSEA=.464, PCLOSE=.000. Since all paths in the model were significant, (except for the control variable i.e. age), the model could not be trimmed. (Note that the path from decoding to Comprehension here was significant).

Arabic Comprehension Fluency Model

The initial hypothesised model did not provide a good fit (it was saturated) $\chi 2$ (probability could not be completed), CFI=1.000, RMSEA=.408, PCLOSE=.000. After deleting insignificant paths (as discussed before), the final model provided a good fit: $\chi 2$ (2) = .685, p=.710, CFI=1.000, RMSEA=.000, PCLOSE=.750 (see Figure 5.15). The model shows that decoding is directly related to Comprehension Fluency. Both sound deletion and word chain are indirectly related to Comprehension Fluency (Note that the comprehension fluency measure was non-marked).

English Comprehension Model

When trying to build a model, it did not provide a good fit: $\chi 2$ (the model was saturated and probability could not be completed), CFI=1.000, RMSEA=.450, PCLOSE=.000. After deleting insignificant paths (as discussed before), the final model provided a good fit: $\chi 2$ (1) = .008, p=.930, CFI=1.000, RMSEA=.000, PCLOSE=.936 (see Figure 5.16). The model shows that sound deletion and word chain are directly related to English Comprehension.

English Comprehension Fluency Model

When trying to build a model, it did not provide a good fit: $\chi 2$ (the model was saturated and probability could not be completed), CFI=1.000, RMSEA=.415, PCLOSE=.000. After deleting insignificant paths (as discussed before), the final model provided a good fit: $\chi 2$ (2) = 1.763, p=.414, CFI=1.000, RMSEA=.000, PCLOSE=.475 (see Figure 5.17). The model shows that word chain is directly related to English Comprehension.

Arabic Text Spelling Model

When trying to build a model, it did not provide a good fit: $\chi 2$ (the model was saturated and probability could not be completed), CFI=1.000, RMSEA=.468, PCLOSE=.000. After deleting insignificant paths (as discussed before), the final model provided a good fit: $\chi 2$ (1) = .026, p=.872, CFI=1.000, RMSEA=.000, PCLOSE=.883 (see Figure 5.18). The model shows that sound deletion and decoding are directly related to Arabic Text Spelling. It also shows that word chain is indirectly related to Text Spelling via word spelling.

English Text Spelling Model

When trying to build a model, it did not provide a good fit: $\chi 2$ (the model was saturated and probability could not be completed), CFI=1.000, RMSEA=.508, PCLOSE=.000. After deleting insignificant paths (as discussed before), the final model provided a good fit: $\chi 2$ (1) = .338, p=.561, CFI=1.000, RMSEA=.000, PCLOSE=.594 (see Figure 5.19). The model shows that word chain and decoding are directly related to Arabic Text Spelling. It also shows that sound deletion is indirectly related to Text Spelling via word spelling.

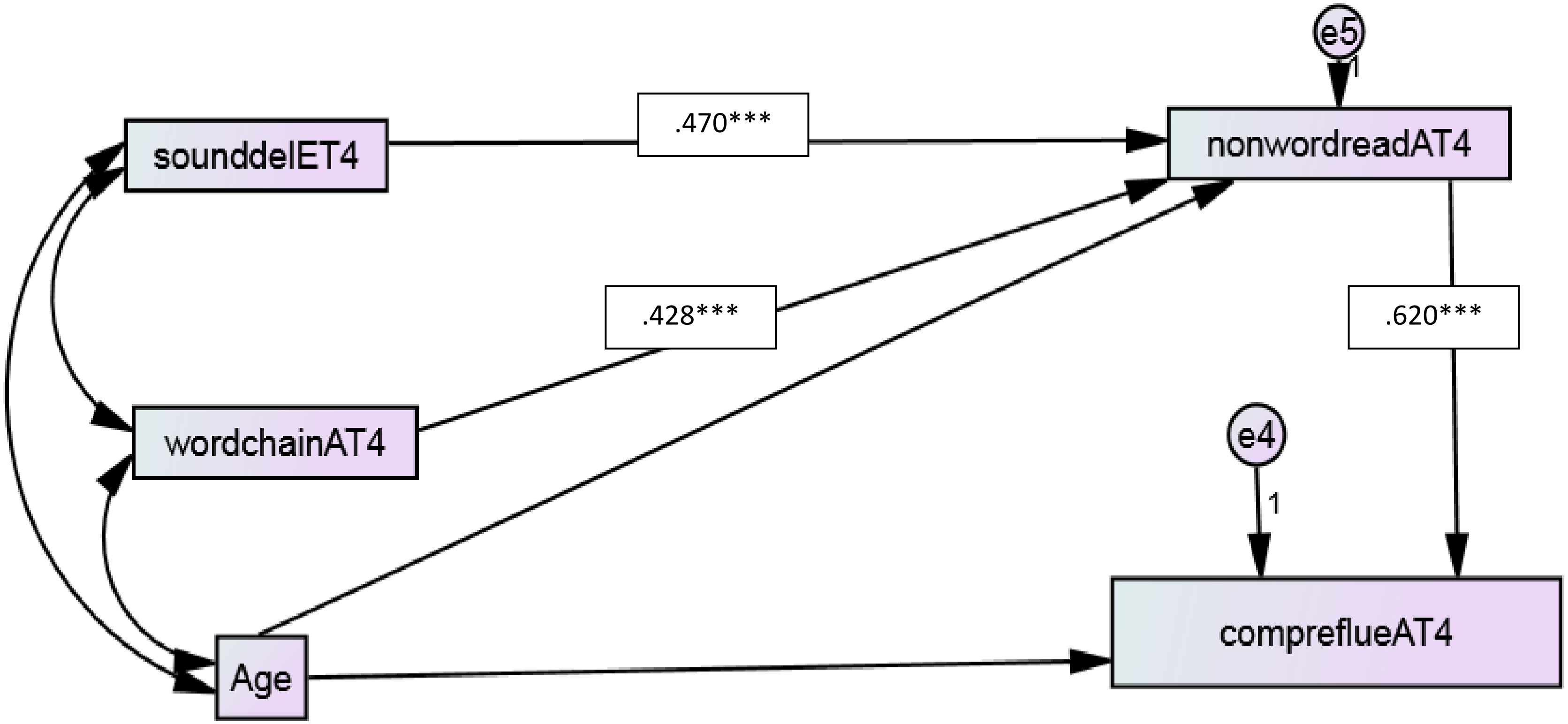
Arabic Composition Coherence Model

When trying to build a model, it did not provide a good fit: $\chi 2$ (the model was saturated and probability could not be completed), CFI=1.000, RMSEA=.392, PCLOSE=.000. After deleting insignificant paths (as discussed before), the final model did not provide a good fit: $\chi 2$ (2) = 5.011, p=.082, CFI=.972, RMSEA=.147, PCLOSE=.118

English Composition Coherence Model

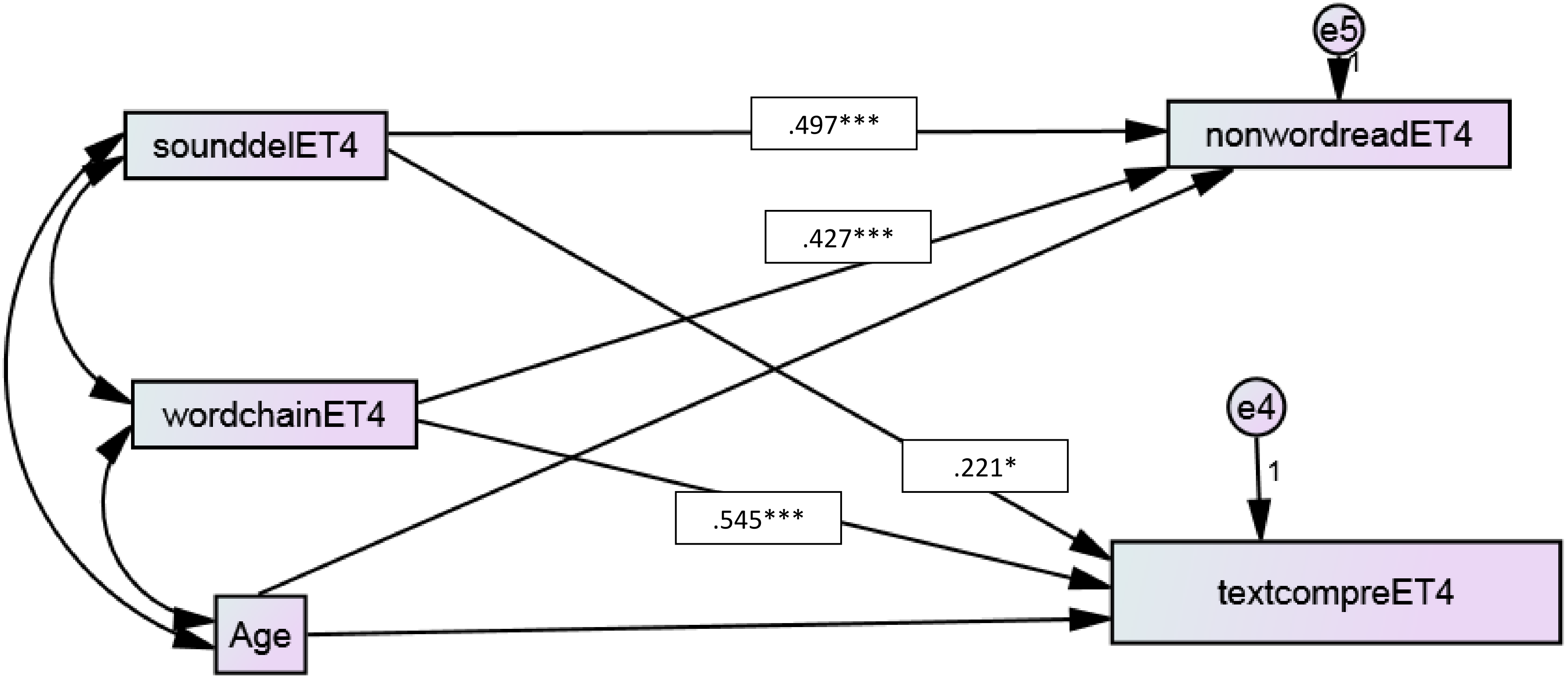
When trying to build a model, it did not provide a good fit: $\chi 2$ (the model was saturated and probability could not be completed), CFI=1.000, RMSEA=.464, PCLOSE=.000. After deleting insignificant paths (as discussed before), the final model provided a good fit: $\chi 2$ (1) = 1.330, p=.249, CFI=.998, RMSEA=.069, PCLOSE=.289. The model shows that decoding and word chain are directly related to English Composition Coherence. It also shows that Sound Deletion is indirectly related to it (see Figure 5.20).

Figure 5.15 Path diagram to show the concurrent relations between variables from Time 4 to Time 4 Arabic Comprehension Fluency



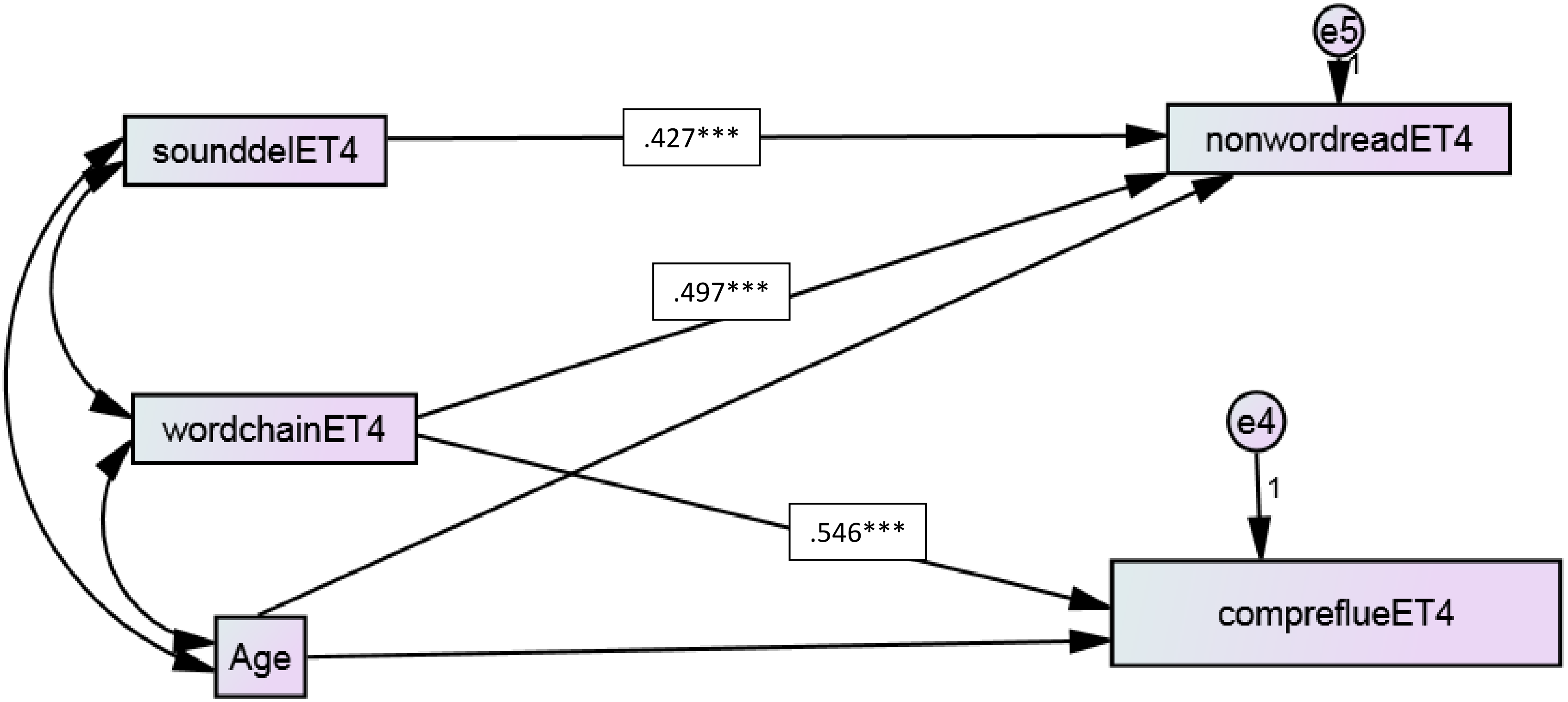
Note. Numbers in the figure are standardised regression weights. **p*=.05. ***p*=.01.****p* < .001

Figure 5.16 Path diagram to show the concurrent relations between variables from Time 4 to Time 4 English Comprehension



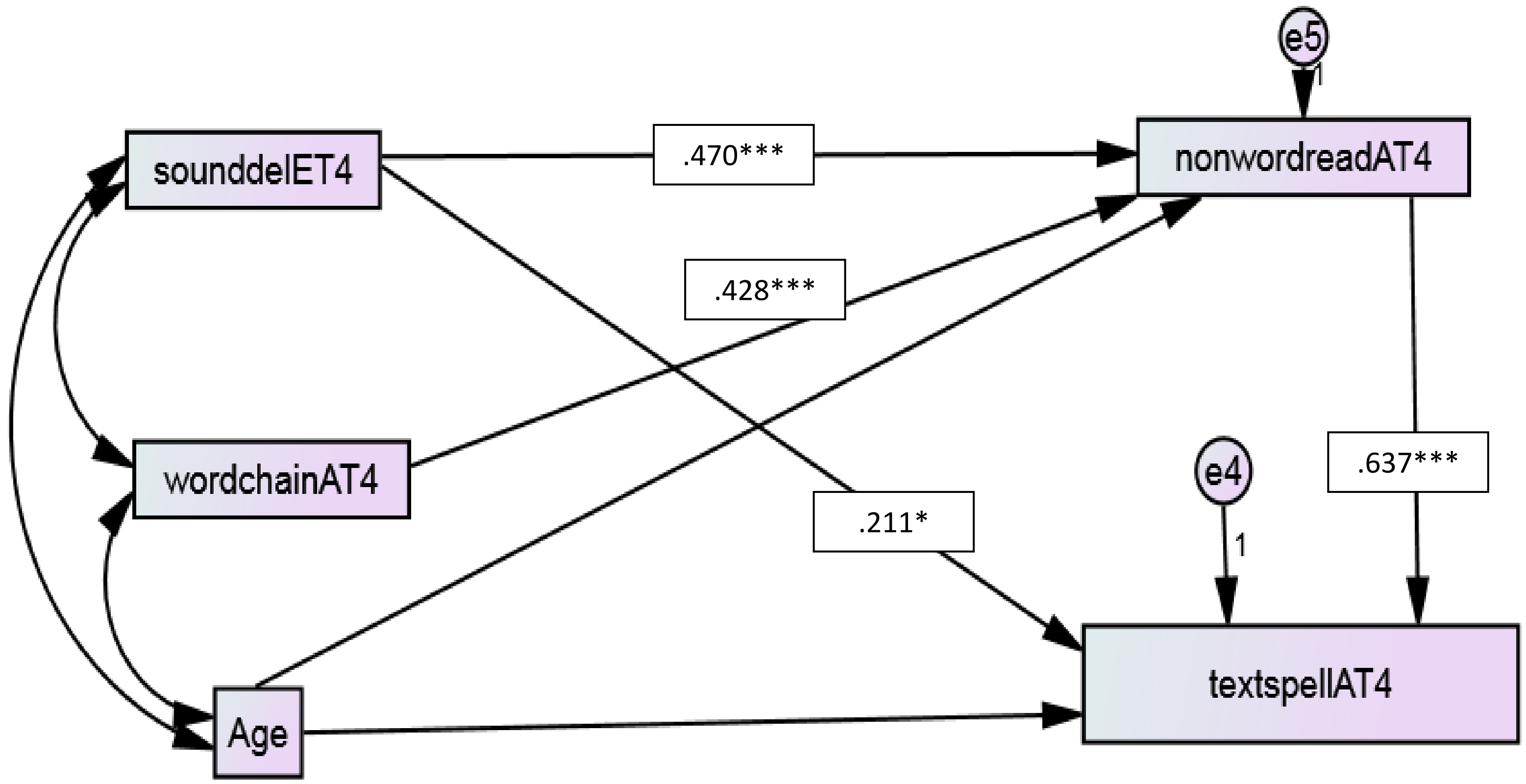
Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001

Figure 5.17 Path diagram to show the concurrent relations between variables from Time 4 to Time 4 English Comprehension Fluency



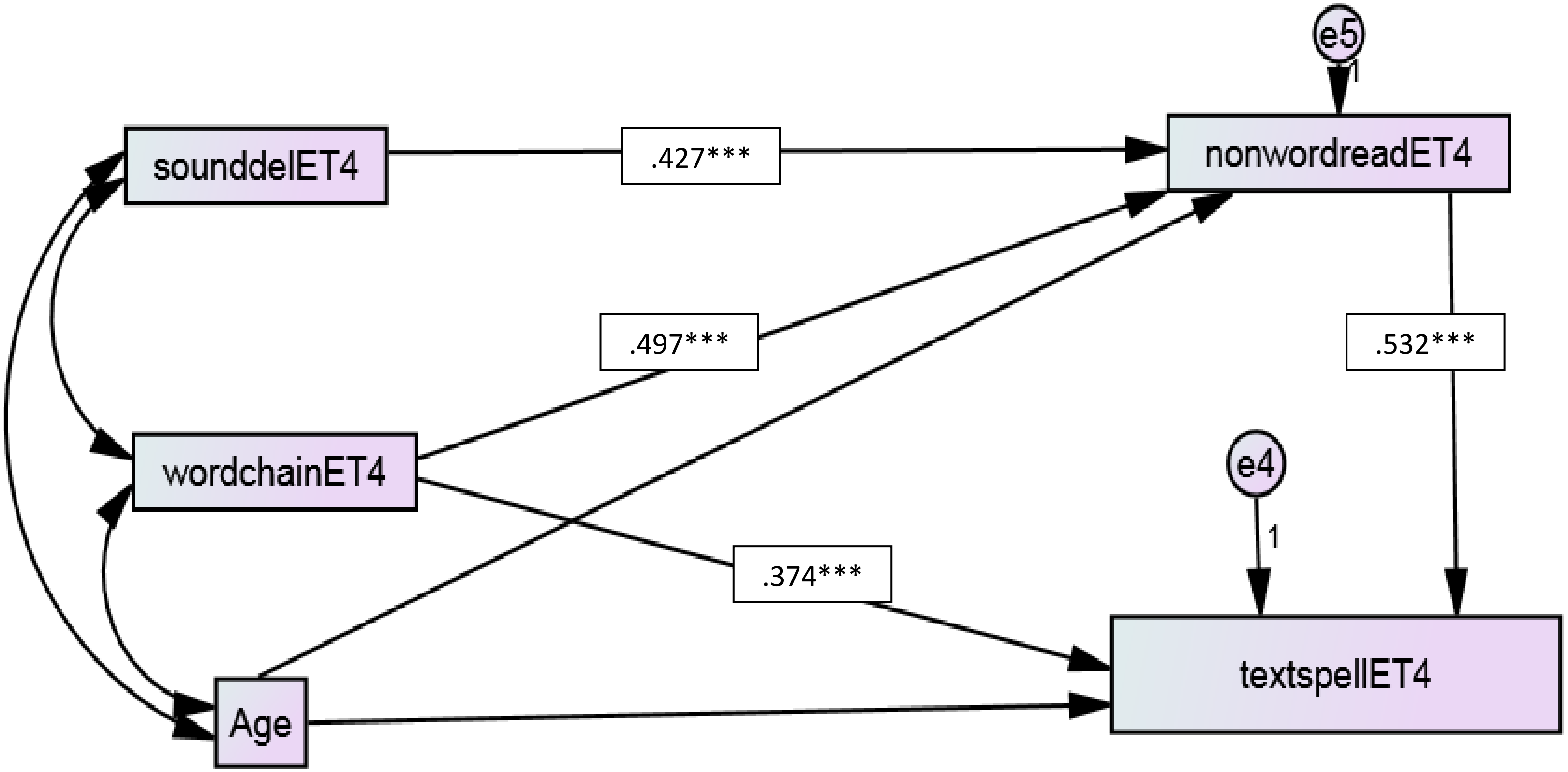
Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$

Figure 5.18 Path diagram to show the concurrent relations between variables from Time 4 to Time 4 Arabic Text Spelling



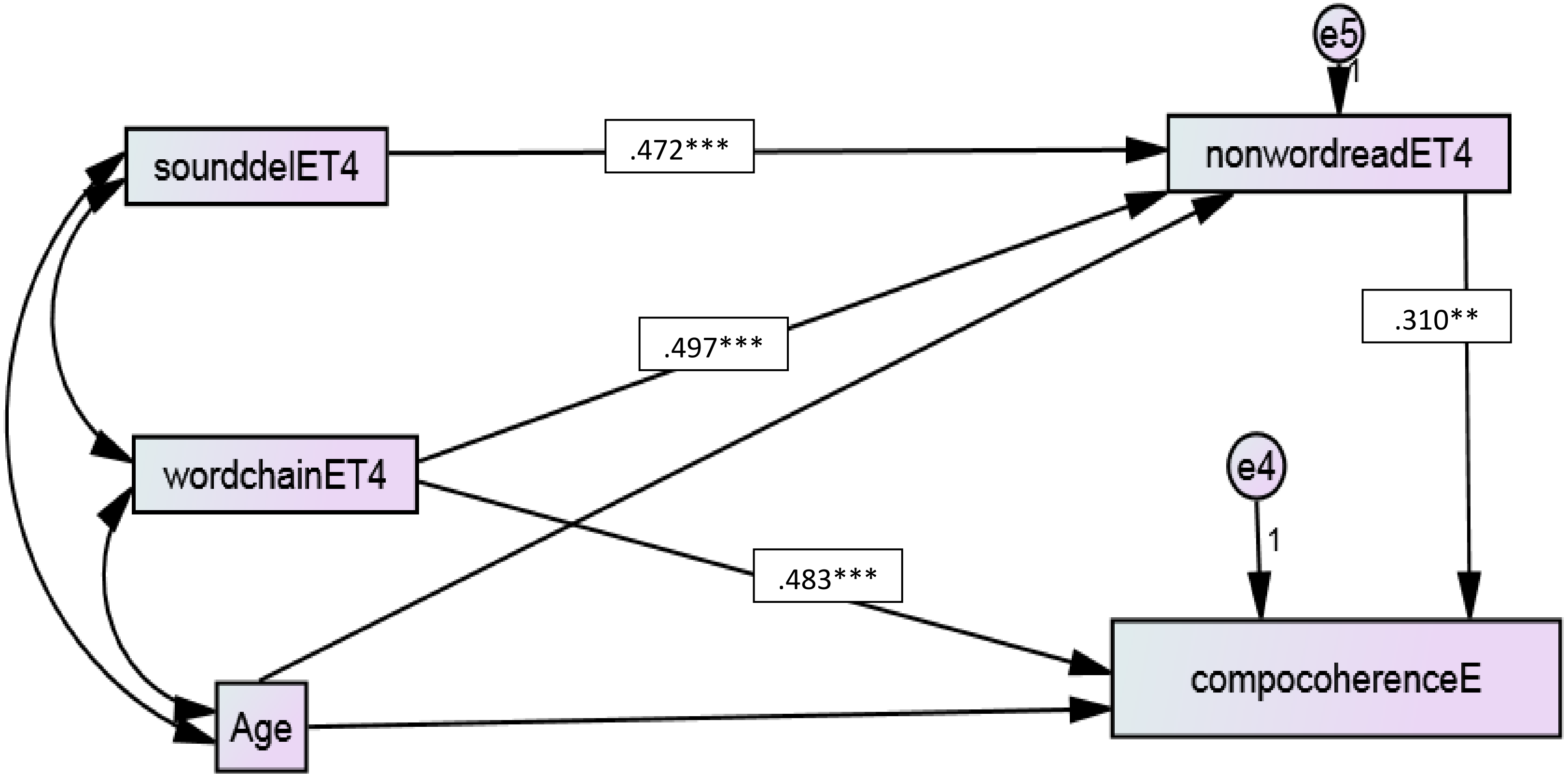
Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001

Figure 5.19 Path diagram to show the concurrent relations between variables from Time 4 to Time 4 English Text Spelling



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001

Figure 5.20 Path diagram to show the concurrent relations between variables from Time 4 to Time 4 English Composition Coherence



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$

Chapter Six: Cross-Time Results

The aim of this chapter is to investigate longitudinal predictors of the study literacy measure. The effects of Time 1, Time 2 and Time 3 variables are investigated one at a time to see which variables predicted the outcome measures of the study best. The chapter starts with tables that demonstrate correlations between Times 1, 2 and 3 and Time 4 outcome variables for both Arabic and English measures (respectively) and the non-language measures. Then, the effects of Time 1, Time 2 and Time 3 variables on Arabic Marked-Text Comprehension are investigated using regression analysis, followed by path analysis for each group of variables in a specific time of the study. The same process is applied to Arabic non-marked text comprehension, English text comprehension, Arabic comprehension fluency, English comprehension fluency, Arabic Text Spelling, English Text Spelling, Arabic composition coherence, Arabic composition correct words (correctly spelt words), English composition coherence, and finally English composition correct words (correctly spelt words). Finally, the longitudinal effects of Time 1 variables on Time 2 and Time 3 Arabic word reading and text reading fluency are investigated in the same way. The way variables are entered into equations, and the way regression results tables are organised are the same as explained at the beginning of Chapter 5.

In each of the times of the study, regression analyses are followed by path analyses to further confirm, or modify the findings. We conducted simple regression-based path models of the longitudinal relations between the observed variables of that time in the prediction of Time 4 variable using AMOS 21 in a similar way to what we did in the previous chapter. Based on the regression analyses and final path models, predictors of Time 4 were indicated at the end of each set.

Table 6.1 demonstrates correlations of Time 1 Arabic measures and the non-language measures with Time 4 Arabic outcome measures. Table 6.2 demonstrates correlations of Time 2 and Time 3 Arabic measures and the non-language measures with Time 4 Arabic outcome measures. Table 6.3 demonstrates correlations of Time 1 English measures and the non-language measures with Time 4 English outcome measures. Table 6.4 demonstrates correlations of Time 2 and Time 3 English measures and the non-language measures with Time 4 English outcome measures. Table 6.5

demonstrates correlations of Time 1 English measures and the non-language measures with Time 4 Arabic outcome measures. Table 6.6 demonstrates correlations of Time 2 and Time 3 English measures and the non-language measures with Time 4 Arabic outcome measures. Table 6.7 demonstrates correlations of Time 1 Arabic measures and the non-language measures with Time 4 English outcome measures. Table 6.8 demonstrates correlations of Time 2 and Time 3 Arabic measures and the non-language measures with Time 4 English outcome measures.

Table 6.1 shows that Arabic Marked-Text Comprehension, Non-Marked Text Comprehension and Text Spelling correlate with all Time 1 Arabic measures (demonstrated in the table) except for Orthographic Discrimination. Arabic Comprehension Fluency correlates with all Time 1 Arabic measures except for Non-Word Repetition. Arabic Composition Coherence correlates with all Time 1 Arabic measures except for RAN, Orthographic Discrimination and Word Chain.

Table 6.2 shows that Arabic, Non-Marked Text Comprehension, Comprehension Fluency and Text Spelling correlate with all Time 2 and Time 3 Arabic measures (demonstrated in the table). Arabic Marked-Text Comprehension correlates with all Time 2 and Time 3 Arabic measures (demonstrated in the table) except for Orthographic Discrimination (which is used only in Time 3). Arabic Composition Coherence correlates with all Time 2 and Time 3 Arabic measures (demonstrated in the table) except for Time 2 and Time 3 word chain and Time 3 Orthographic Discrimination.

Table 6.3 shows that English Text Spelling and Composition Coherence correlate with all Time 1 English measures (demonstrated in the table). English Text Comprehension correlates with all Time 1 English measures except for visual memory. English Comprehension Fluency correlates with all Time 1 English measures except for Non-Word repetition, Orthographic Discrimination and Visual memory.

Table 6.4 shows that English Text Comprehension, Comprehension Fluency, Text Spelling and Composition Coherence correlate with all Time 2 and Time 3 English measures (demonstrated in the table).

Table 6.5 shows that Arabic Marked-Text Comprehension and Non-Marked Text Comprehension correlate with all Time 1 English measures (demonstrated in the table) except for Non-Word Repetition and Orthographic Discrimination. Arabic Comprehension Fluency correlates with all Time 1 English measures except for Vocabulary, Non-Word Repetition, and Orthographic Discrimination. Arabic Text Spelling correlates with all Time 1 English measures (demonstrated in the table) except for Orthographic Discrimination. Arabic Composition Coherence correlates with all Time 1 English measures except for Non-Word Repetition, Orthographic Discrimination and Word Chain.

Table 6.6 shows that Arabic Non-Marked Text Comprehension, Marked Text Comprehension and Text Spelling correlate with all Time 2 and Time 3 English measures (demonstrated in the table) except for Time 3 orthographic discrimination. Arabic Comprehension Fluency correlates with all Time 2 and Time 3 English measures (demonstrated in the table) except for Time 2 and Time 3 vocabulary. Arabic Composition Coherence correlates with all Time 2 and Time 3 English measures (demonstrated in the table) except for Time 3 word chain and Orthographic Discrimination.

Table 6.7 shows that English Text comprehension correlates with all Time 1 Arabic measure except for vocabulary, RAN, and Orthographic Discrimination. English Comprehension Fluency correlates with Time 1 Arabic word reading, text reading fluency, word spelling, sound deletion, non-word repetition, word chain, and Morpho-syntactic processing. English Text Spelling and Composition Coherence both correlate with all Time 1 Arabic measures except for vocabulary and Orthographic Discrimination.

Table 6.8 shows that English Text Comprehension correlates with all Time 2 and Time 3 Arabic measures except for Time 3 vocabulary and RAN. English Comprehension Fluency correlates with all Time 2 and Time 3 Arabic measures except for Time 2 and Time 3 non-word reading, and Time 3 vocabulary and syntactic awareness. English Text Spelling and Composition Coherence both correlate with all Time 2 and Time 3 Arabic measures except for Time 3 vocabulary.

Table 6.1 Correlations of Time 1 for Arabic measures and the non-language measures with Time 4 outcome measures.

Arabic	Marked Text Comprehension	Non-Marked Text Comprehension	Comprehension Fluency	Text Spelling	Composition Coherence
word reading	.553**	.649**	.626**	.785**	.514**
text reading fluency	.502**	.614**	.734**	.720**	.515**
word spelling	.517**	.616**	.632**	.761**	.468**
Non-word Reading	.373**	.575**	.425**	.636**	.448**
Vocabulary	.311**	.301*	.416**	.298*	.285*
Sound Deletion	.396**	.573**	.523**	.671**	.401**
Rapid Naming	-.304**	-.407**	-.461**	-.395**	-.181
Non-word Repetition	.275*	.326**	.149	.338**	.279**
Orthographic Discrimination	.011	-.017	.260*	.006	-.014
Word Chain	.234*	.314**	.237*	.398**	.178
Visual Memory	.338**	.427**	.321**	.485**	.421**
Syntactic Awareness	.435**	.555**	.504**	.618**	.525**
Morphological Segmentation	.428**	.618**	.487**	.580**	.468**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Table 6.2 Correlations of Time 2 and Time 3 for Arabic measures and the non-language measures with Time 4 outcome measures.

	Arabic	Marked Text Comprehension	Non-Marked Text Comprehension	Comprehension Fluency	Text Spelling	Composition Coherence
Time 2	word reading	.587**	.733**	.666**	.886**	.616**
	text reading fluency	.512**	.667**	.757**	.715**	.500**
	word spelling	.515**	.614**	.522**	.782**	.540**
	Non-word Reading	.457**	.609**	.558**	.759**	.381**
	Vocabulary	.458**	.527**	.393**	.453**	.395**
	Word chain	.469**	.402**	.438**	.513**	.198
Time 3	word reading	.472**	.597**	.514**	.648**	.463**
	text reading fluency	.520**	.690**	.726**	.694**	.496**
	word spelling	.467**	.616**	.575**	.808**	.583**
	Non-word Reading	.317**	.507**	.351**	.508**	.257*
	Vocabulary	.247*	.239**	.258*	.290*	.296*
	Rapid Naming	-.411**	-.427**	-.491**	-.403**	-.251*
	Orthographic discrimination	.200	.275*	.415**	.327**	.227
	Word Chain	.546**	.560**	.407**	.505**	.132
	Syntactic Awareness	.477**	.502**	.571**	.614**	.535**
	Morphological Segmentation	.559**	.618**	.484**	.615**	.409**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Tables 6.3 Correlations of Time 1 for English measures and the non-language measures with Time 4 outcome measures.

English	Text Comprehension	Comprehension Fluency	Text Spelling	Composition Coherence
word reading	.611**	.418**	.721**	.677**
text reading fluency	.670**	.511**	.732**	.650**
word spelling	.352**	.275*	.535**	.542**
Non-word Reading	.641**	.393**	.747**	.657**
Vocabulary	.441**	.326**	.519**	.525**
Sound Deletion	.486**	.336**	.452**	.419**
Rapid Naming	-.446**	-.377**	-.562**	-.513**
Non-word Repetition	.244*	.198	.318**	.241*
Orthographic Discrimination	.371**	.192	.242*	.268*
Word Chain	.552**	.508**	.618**	.621**
Visual Memory	.182	.068	.282*	.325**
Syntactic Awareness	.454**	.253*	.586**	.558**
Morphological Segmentation	.628**	.339**	.554**	.600**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Tables 6.4 Correlations of Time 2 and Time 3 for English measures and the non-language measures with Time 4 outcome measures.

	English	Text Comprehension	Comprehension Fluency	Text Spelling	Composition Coherence
Time 2	word reading	.672**	.589**	.866**	.768**
	text reading fluency	.687**	.606**	.789**	.650**
	word spelling	.614**	.493**	.829**	.743**
	Non-word Reading	.586**	.501**	.854**	.696**
	Vocabulary	.364**	.300**	.499**	.519**
	Word chain	.587**	.544**	.649**	.570**
Time 3	word reading	.650**	.538**	.861**	.771**
	text reading fluency	.661**	.613**	.854**	.700**
	word spelling	.628**	.363**	.805**	.711**
	Non-word Reading	.597**	.457**	.798**	.677**
	Vocabulary	.527**	.329**	.585**	.570**
	Rapid Naming	-.314**	-.298*	-.521**	-.499**
	Orthographic discrimination	.299*	.318**	.369**	.292*
	Word Chain	.592**	.607**	.672**	.643**
	Syntactic Awareness	.517**	.250*	.640**	.670**
	Morphological Segmentation	.546**	.386**	.565**	.519**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Table 6.5 Correlations of Time 1 for English measures and the non-language measures with Time 4 Arabic outcome measures.

Arabic / English	Marked Text Comprehension	Non-Marked Text Comprehension	Comprehension Fluency	Text Spelling	Composition Coherence
word reading	.506**	.565**	.432**	.616**	.403**
text reading fluency	.402**	.469**	.415**	.446**	.331**
word spelling	.154	.330**	.398**	.391**	.238*
Non-word Reading	.501**	.616**	.403**	.672**	.339**
Vocabulary	.401**	.374**	.217	.258*	.365**
Sound Deletion	.434**	.495**	.445**	.569**	.285*
Rapid Naming	-.475**	-.477**	-.289*	-.498**	-.487**
Non-word Repetition	.100	.180	.141	.300*	.085
Orthographic Discrimination	-.014	.126	.193	.052	-.021
Word Chain	.343**	.309**	.276*	.297*	.195
Syntactic Awareness	.466**	.430**	.275*	.470**	.362**
Morphological Segmentation	.409**	.444**	.461**	.436**	.341**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Table 6.6 Correlations of Time 2 and Time 3 for English measures and the non-language measures with Time 4 Arabic outcome measures.

	English \ Arabic	Marked Text Comprehension	Non-Marked Text Comprehension	Comprehension Fluency	Text Spelling	Composition Coherence
Time 2	word reading	.529**	.589**	.538**	.652**	.460**
	text reading fluency	.500**	.574**	.487**	.542**	.350**
	word spelling	.500**	.330**	.441**	.596**	.371**
	Non-word Reading	.522**	.640**	.536**	.764**	.402**
	Vocabulary	.363**	.309**	.166	.299*	.374**
	Word chain	.389**	.397**	.353**	.500**	.307**
Time 3	word reading	.550**	.632**	.465**	.646**	.400**
	text reading fluency	.510**	.625**	.549**	.622**	.367**
	word spelling	.456**	.570**	.504**	.617**	.435**
	Non-word Reading	.528**	.623**	.405**	.586**	.344**
	Vocabulary	.487**	.390**	.181	.321**	.360**
	Rapid Naming	-.370**	-.342**	-.291*	-.367**	-.338**
	Orthographic discrimination	.106	.206	.439**	.156	.119
	Word Chain	.467**	.452**	.343**	.436**	.213
	Syntactic Awareness	.369**	.395**	.404**	.491**	.454**
	Morphological Segmentation	.419**	.407**	.254*	.394**	.254*

** Correlation is significant at the 0.01 level
 * Correlation is significant at the 0.05 level

Table 6.7 Correlations of Time 1 for Arabic measures and the non-language measures with Time 4 English outcome measures.

English / Arabic	Text Comprehension	Comprehension Fluency	Text Spelling	Composition Coherence
word reading	.425**	.245*	.620**	.545**
text reading fluency	.417**	.458**	.658**	.586**
word spelling	.392**	.323**	.584**	.555**
Non-word Reading	.445**	.152	.578**	.484**
Vocabulary	.025	.099	.124	.121
Sound Deletion	.388**	.297*	.492**	.479**
Rapid Naming	-.181	-.052	-.263*	-.257*
Non-word Repetition	.234*	.273*	.296*	.383**
Orthographic Discrimination	.028	.056	-.021	.148
Word Chain	.325**	.271*	.384**	.238*
Syntactic Awareness	.308**	.208	.527**	.469**
Morphological Segmentation	.586**	.143	.555**	.498**

** Correlation is significant at the 0.01 level
 * Correlation is significant at the 0.05 level

Table 6.8 Correlations of Time 2 and Time 3 for Arabic measures and the non-language measures with Time 4 English outcome measures.

	Arabic \ English	Text Comprehension	Comprehension Fluency	Text Spelling	Composition Coherence
Time 2	word reading	.470**	.382**	.714**	.623**
	text reading fluency	.392**	.475**	.615**	.511**
	word spelling	.473**	.407**	.690**	.578**
	Non-word Reading	.469**	.207	.633**	.566**
	Vocabulary	.235*	.252*	.440**	.400**
	Word chain	.403**	.423**	.445**	.399**
Time 3	word reading	.474**	.440**	.675**	.611**
	text reading fluency	.395**	.383**	.589**	.448**
	word spelling	.403**	.245*	.682**	.620**
	Non-word Reading	.368**	.194	.556**	.463**
	Vocabulary	.102	.020	.105	.134
	Rapid Naming	-.188	-.298*	-.353**	-.339**
	Orthographic discrimination	.452**	.319**	.436**	.455**
	Word Chain	.395**	.314**	.430**	.314**
	Syntactic Awareness	.298*	.166	.431**	.392**
	Morphological Segmentation	.519**	.335**	.548**	.531**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Arabic Marked-Text Comprehension

Time 1 variables

When investigating variance by measures of Time 1 on Arabic Marked-Text Comprehension. A set of regressing analyses was conducted. For each set of these analyses, Time 4 Arabic Marked-Text Comprehension was the dependent variable. The independent variables were Time 1 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and Morpho-syntactic skills. The independent variables were entered in a set order. In each analysis, age was controlled for by being entered as step one. The results in Table 6.9 show that when controlling for age, word reading added 32% of unique variance. When controlling for age and word reading, the only variable that added unique variance was vocabulary since it added 5% of unique variance. From this set of analyses, it could be concluded then that the main Time 1 predictor of Arabic marked-text comprehension is word reading. Vocabulary contributed slightly to predicting marked-text comprehension.

Path Analyses

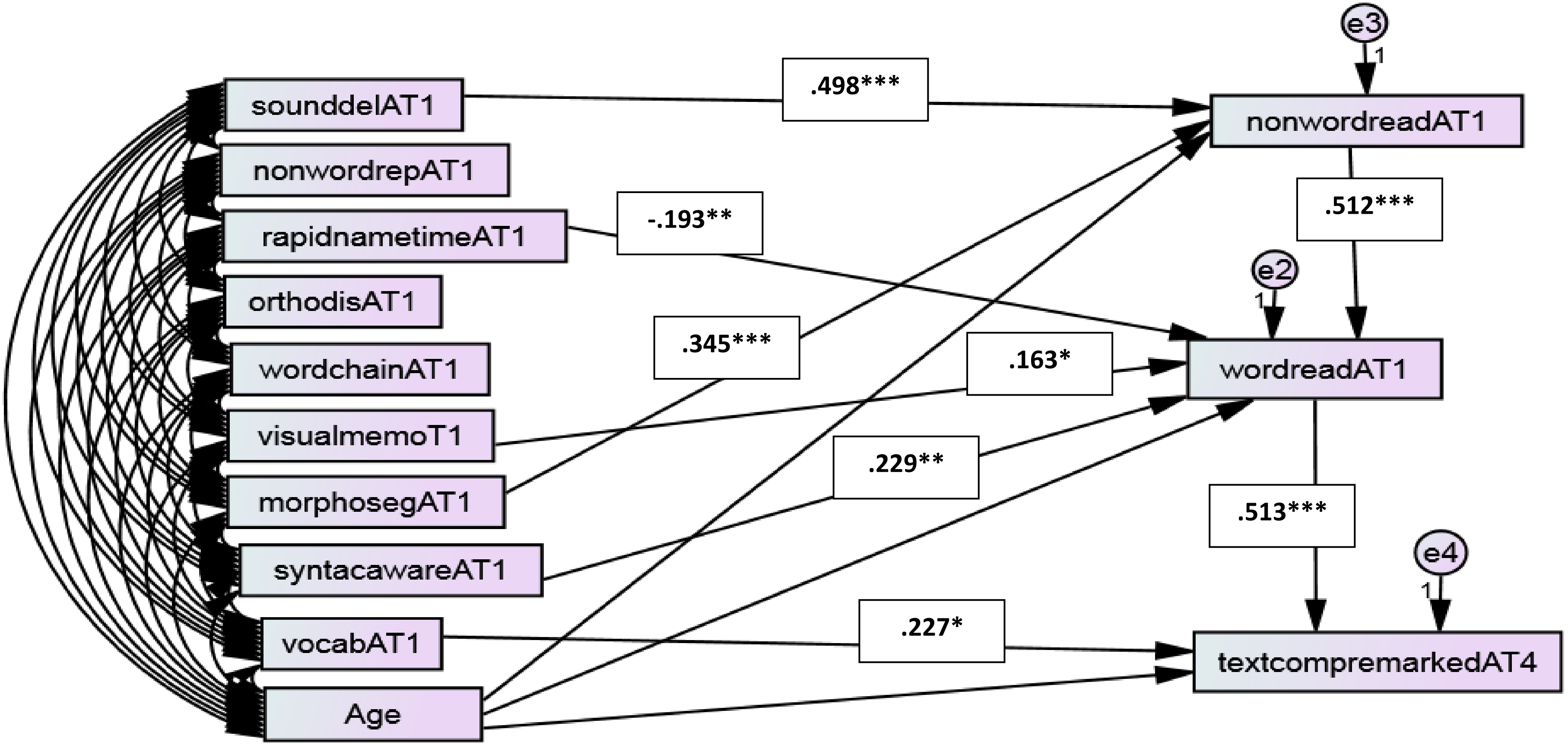
Based on results from Word Reading Model in Chapter 5 (see Model 5.1), paths from Time 1 morphological segmentation and sound deletion to Time 1 Decoding (which was used as a mediator), then from Time 1 Decoding, RAN, Visual Memory and Syntactic Awareness to Time 1 word reading (which was also used as a mediator). We then added all possible paths from exogenous variables, in addition to decoding and word reading, to Marked-Text Comprehension. We controlled for age as discussed before. We allowed the Time 1 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi2(13)= 14.489$, p=.341, CFI=.994, RMSEA=.040, PCLOSE=.503. To build a simpler model, we used variables with significant paths only (See Figure 8.1). The model provided a good fit to the data set: $\chi2(22)= 18.845$, p=.655, CFI=1.000, RMSEA=.000, PCLOSE=.817. The model confirms the previous finding that Time 1 word reading and vocabulary are directly related to comprehension. The findings also indicate that Time 1 decoding, syntactic awareness, visual memory and rapid naming are indirectly related to comprehension via word reading. Sound deletion and morphological segmentation are also indirectly related to it via decoding and then word reading.

When trying to build another model with morpho-syntactic skills as mediators, the model provided the same results: i.e. the only variables that predicted marked-text comprehension were word reading and vocabulary. In addition, neither morphological segmentation nor syntactic awareness had significant paths to comprehension. Therefore, although the model had a good fit, it was rejected since it did not add any further understanding of the relationships amongst the variables.

Table 6.9 Regression analysis to investigate Time 1 predictors of Arabic Marked-Text Comprehension

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.161	.149	F(1,68)=12.089 p=.001	non-word reading	-.051-
	2	word reading	.331	.170	F(1,67)=17.012 p=.000	.363	
II	1	word reading	.330	.318	F(1,68)=32.323 p=.000		
	2	decoding	.331	.001	F(1,67)=.068 p=.796		
III	3	vocabulary	.377	.046	F(1,66)=4.830 p=.031	.158	
	4	Morpho-syntactic awareness	.392	.015	F(2,64)=.808 p=.450	syntactic awareness	.129
						morphological segmentation	.066
IV	3	Morpho-syntactic awareness	.368	.037	F(2,65)=1.925 p=.154		
	4	vocabulary	.392	.024	F(1,64)=2.480 p=.120		
V	3	phonological processing	.404	.012	F(3,61)=.407 p=.748	sound deletion	-.036-
						rapid naming	-.044-
						non-word repetition	.121
	4	orthographic processing	.414	.010	F(3,58)=.335 p=.800	orthographic discrimination	.008
						word chain	.111
						visual memory	.044
VI	3	orthographic processing	.401	.009	F(3,61)=.295 p=.829		
	4	phonological processing	.414	.013	F(3,58)=.442 p=.724		

Figure 6.1 Path diagram to show the relations between variables from Time 1 to Time 4 Arabic marked reading comprehension.



Note. Numbers in the figure are standardised regression weights. ∗*p*=.05. ∗∗*p*=.01.∗∗∗*p* < .001.

Time 2 Variables

The variance by measures of Time 2 on Time 4 Marked-Text Comprehension was tested with a set of regressing analysis. For each set of these analyses, Time 4 Marked-Text Comprehension was the dependent variable. The independent variables were Time2 decoding skills, word reading, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The data in Table 6.10 show that, after controlling for age, when decoding was entered before word reading it explained 22% of variability while word reading explained 13%. When word reading was entered first, it explained 35% while decoding, similar to Time 1 results, became insignificant. When vocabulary was entered before orthographic processing, it explained 6% of variability, while orthographic processing explained 5%. When the order was reversed both orthographic processing explained 5%, and vocabulary explained 6%. When controlling for word reading and decoding, vocabulary still added a unique variance, and when controlling for word reading, decoding, and vocabulary; orthographic processing also added unique variance. These results show that the main Time 2 predictor of Arabic Marked-Text Comprehension is word reading, in addition to vocabulary and orthographic processing.

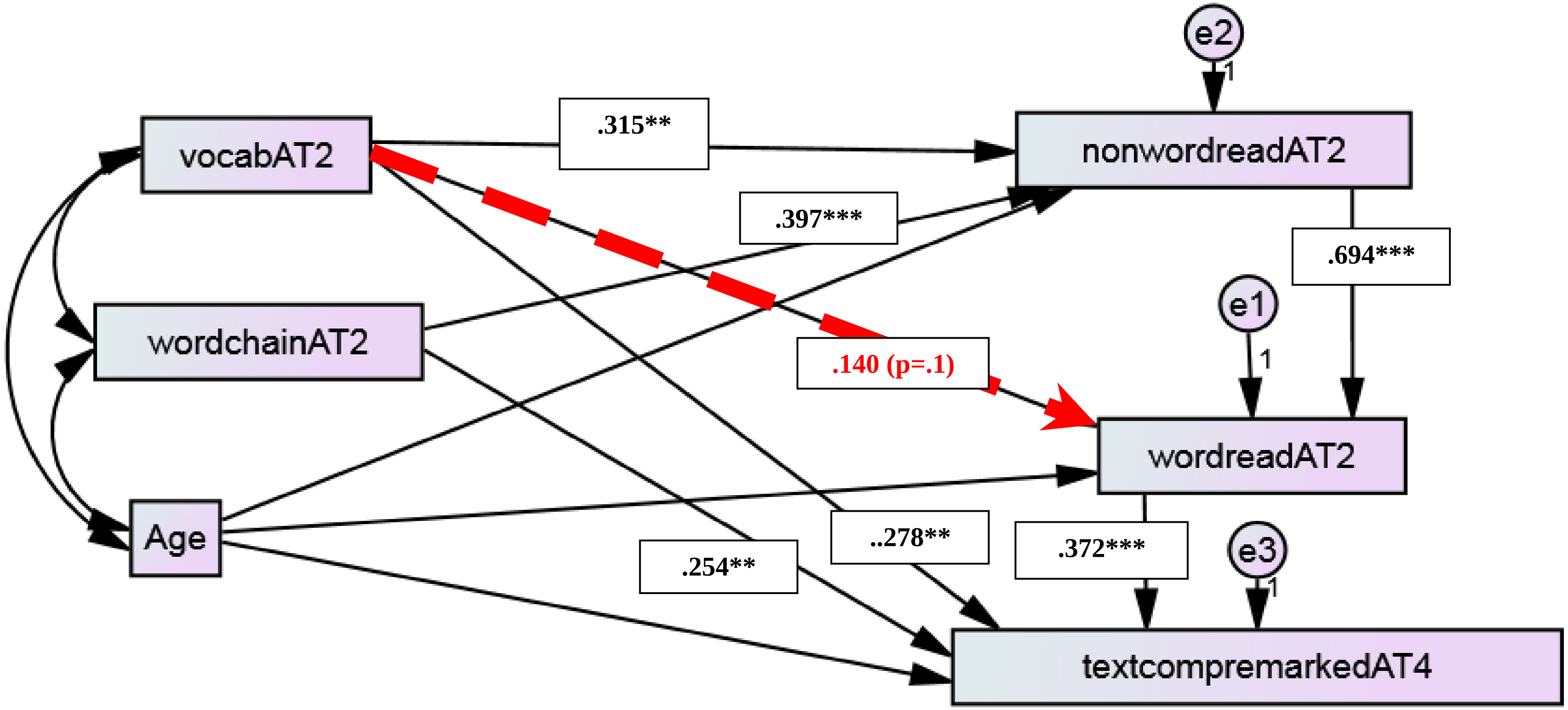
Path Analyses

Based on regression results, the initial hypothesised model included paths from Time 2 vocabulary and word chain to Time Decoding and from Time 2 Decoding and Vocabulary to Time 2 Word Reading. Then we had all possible paths from Time 2 variables, in addition to Time 2 decoding and word reading to Time 4 Marked-Text Reading Comprehension. We allowed the Time 2 (exogenous) variables to covary. Age was controlled for as discussed before (See Figure 6.3). The initial hypothesised model did not provide a good fit to the data set: $\chi 2$ (1) = 1.957, p=.162, CFI=.992, RMSEA=.117, PCLOSE=.198. To build a simpler model, we used significant paths only, but the result was a model that was not quite fit $\chi 2$ (3) =4.890, p=.180, CFI=.985, RMSEA=.0095, PCLOSE=.245). Therefore, we kept the path from vocabulary to word reading (which was significant at 0.1 level), and the model that resulted was a better fit (See Figure 6.4). $\chi 2$ (2) = 2.254, p=.324, CFI=.998, RMSEA=.043, PCLOSE=.385. The model shows that vocabulary, word chain, and word reading are directly related to Arabic Marked-Text Comprehension. The findings also indicate that Time 1 decoding is indirectly related to comprehension via word reading. Word chain and vocabulary also have paths via decoding and hence word reading.

Table 6.10 Regression analysis to investigate Time 2 predictors of Arabic Marked-Text Comprehension

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.232	.220	F(1,68)=19.499 p=.000	non-word reading	-.073-
	2	word reading	.365	.133	F(1,67)=14.010 p=.000	.415	
II	1	word reading	.363	.351	F(1,68)= 37.528 p=.000		
	2	decoding	.365	.002	F(1,67)=.170 p=.682		
III	3	vocabulary	.428	.063	F(1,66)=7.278 p=.009	.283	
	4	orthographic processing	.481	.053	F(1,65)=6.635 p=.012	word chain	.263
IV	3	orthographic processing	.417	.052	F(1,66)=5.909 p=.018		
	4	vocabulary	.481	.064	F(1,65)=7.999 p=.006		

Figure 6.2 Path diagram to show the relations between variables from Time 2 to Time 4 Arabic marked reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

(*For regression weights highlighted in red, p.= .110*)

Time 3 Variables

Finally, the variance made by measures of Time 3 on Arabic marked-text comprehension was tested with a set of regressing analysis. For each set of these analyses, Time 4 Arabic marked-text comprehension measure was the dependent variable. The independent variables were Time 3 decoding skills, word reading, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.11 shows regression results to show variance by Time 4 on Arabic marked-text comprehension. The data in Table 6.3 show that, after controlling for age, when decoding was entered before word reading it explained 12% of variability while word reading explained 10%. When word reading was entered first, it explained 22% while decoding, similar to both Time 1 and Time 2 results, became insignificant. After controlling for age, word reading and decoding, when vocabulary was entered before morpho-syntactic skills, it explained 7% of variability, and morpho-syntactic skills explained 15.5%. When the order was reversed morpho-syntactic skills explained 22% and vocabulary became insignificant. When controlling for the previous variables, both phonological processing, and orthographic processing were significant and they both explained about 5% despite changing their order of entry. It could be concluded then that the main Time 3 predictors of Arabic Marked-Text Comprehension are word reading, morpho-syntactic awareness, orthographic processing and phonological processing.

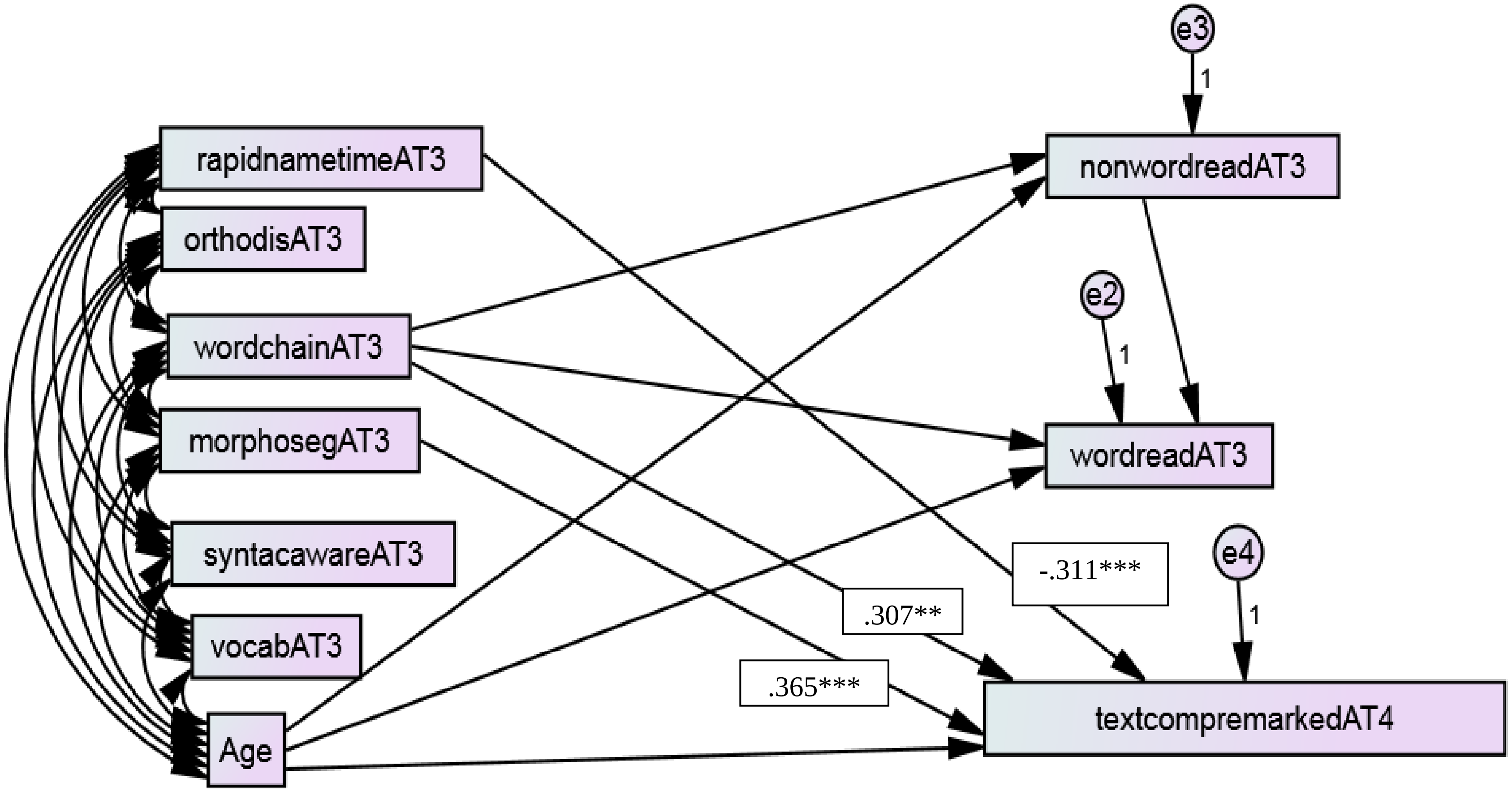
Path Analyses

Based on Model 5.9, the first hypothesised model included paths from Time 3 word chain to Time 3 decoding, and from Time 3 decoding and word chain to Time 3 word reading. Finally, we added paths from all Time 3 exogenous variables, in addition to decoding and word reading to Time 4 reading comprehension. Age was controlled for as previously discussed. We allowed the Time 3 (exogenous) variables to covary. The initial hypothesised model provided an acceptable fit to the data set: $\chi 2$ (10) = 14.951, p=.134, CFI=.977, RMSEA=.084, PCLOSE=.239. To build a simpler model, we used significant paths only. The final model showed a good model fit $\chi 2$ (15) = 20.514, p=.153, CFI=.974, RMSEA=.072, PCLOSE=.292 (See Figure 6.3). The model shows that orthographic processing, morpho-syntactic awareness and phonological processing are the only variables related to marked-text comprehension. Another model was tested which basically had morpho-syntactic skills as mediators, in addition to word reading. The initial hypothesised model had paths from word chain and decoding to word reading (based on previous results: see Chapter 5). Then we had paths from all exogenous variables to both morphological and syntactic processing. Finally, we had paths from all exogenous variables in addition to word reading, syntactic awareness, and morphological segmentation to marked-text comprehension. Based on the modification indices, a path was added from syntactic awareness to morphological segmentation. We then added two paths from word reading to morphological segmentation and from word reading to syntactic awareness. The initial model provided a good fit to the data set: $\chi 2$ (6) = 5.118, p=.529, CFI=1.000 RMSEA=.000, PCLOSE=.623. To build a simpler model we deleted insignificant paths, as discussed before. The final model had a good fit: $\chi 2$ (16) = 14.727, p=.545, CFI=1.000 RMSEA=.000, PCLOSE=.710 (See Figure 6.4). The model shows that (like Model 6.3), that morphological segmentation, RAN, and word chain are directly related to Marked-Text Comprehension. However, the model also shows the indirect effect of other variables. Syntactic awareness and word chain both have indirect paths via morphological skills. Word reading, RAN, and vocabulary have indirect paths via syntactic awareness which in turn predicts morphological segmentation. Similarly, decoding and word chain predict word reading, which is indirectly related Text-Comprehension as discussed.

Table 6.11 Regression analysis to investigate Time 3 predictors of Arabic Marked-Text Comprehension

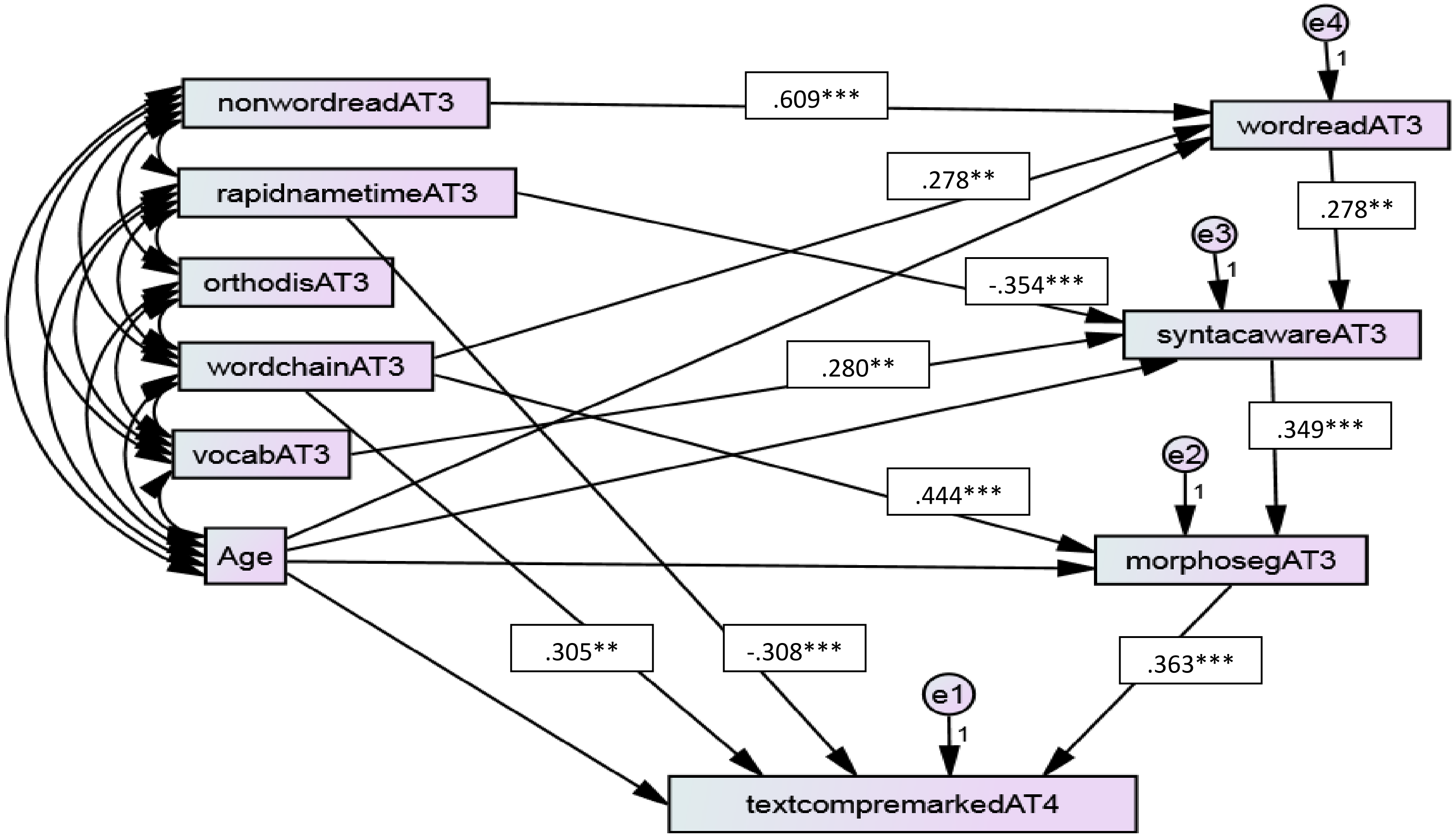
		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.128	.116	F(1,68)=9.064 p=.004	non-word reading	-.121-
	2	word reading	.231	.103	F(1,67)=8.942 p=.004	.191	
II	1	word reading	.231	.219	F(1,68)= 19.348 p=.000		
	2	decoding	.231	.000	F(1,67)=.000 p=.993		
III	3	vocabulary	.298	.067	F(1,66)6.342 p=.014	.009	
	4	Morpho-syntactic awareness	.453	.155	F(2,64)=9.062 p=.000	syntactic awareness	.170
						morphological segmentation	.269
IV	3	Morpho-syntactic awareness	.448	.217	F(2,65)= 12.753 p=.000		
	4	vocabulary	.453	.006	F(1,64)=.646 p=.425		
V	3	phonological awareness	.501	.048	F(1,63)=6.109 p=.016	rapid naming	-.263-
	4	orthographic processing	.553	.051	F(2,61)= 3.480 p=.037	orthographic discrimination	-.056-
						word chain	.285
VI	3	orthographic processing	.511	.058	F(2,62)= 3.696 p=.030		
	4	phonological awareness	.553	.041	F(1,61)=5.608 p=.021		

Figure 6.3 Path diagram to show the relations between variables from Time3 to Time 4 Arabic marked reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$. (Only estimate that have paths to Comprehension are shown)

Figure 6.4 Path diagram to show the relations between variables from Time3 to Time 4 Arabic marked reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

Arabic Non-Marked Text Comprehension

Time 1 Variables

When investigating variance by measures of Time 1 on Arabic Non-Marked Text Comprehension, a set of regressing analysis was conducted. For each set of these analyses, Time 4 outcome measure was the dependent variable. The independent variables were Time 1 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The data in Table 6.4 show that when controlling for age, and decoding was entered before word reading it explained 34% of variability while word reading explained 12%. When word reading was entered first, it explained 43% while decoding became insignificant. When controlling for age, word reading and decoding, and then entering vocabulary before morpho-syntactic awareness, it explained 3% of variability, while morpho-syntactic awareness explained 6.5%. When the order was reversed morpho-syntactic awareness explained 9%, while vocabulary became insignificant. When controlling for the previous variables, both orthographic processing, and phonological awareness were insignificant. From this set of analyses, it could be concluded then that the main Time 1 predictors of Arabic non-marked text comprehension are word reading and morpho-syntactic-awareness.

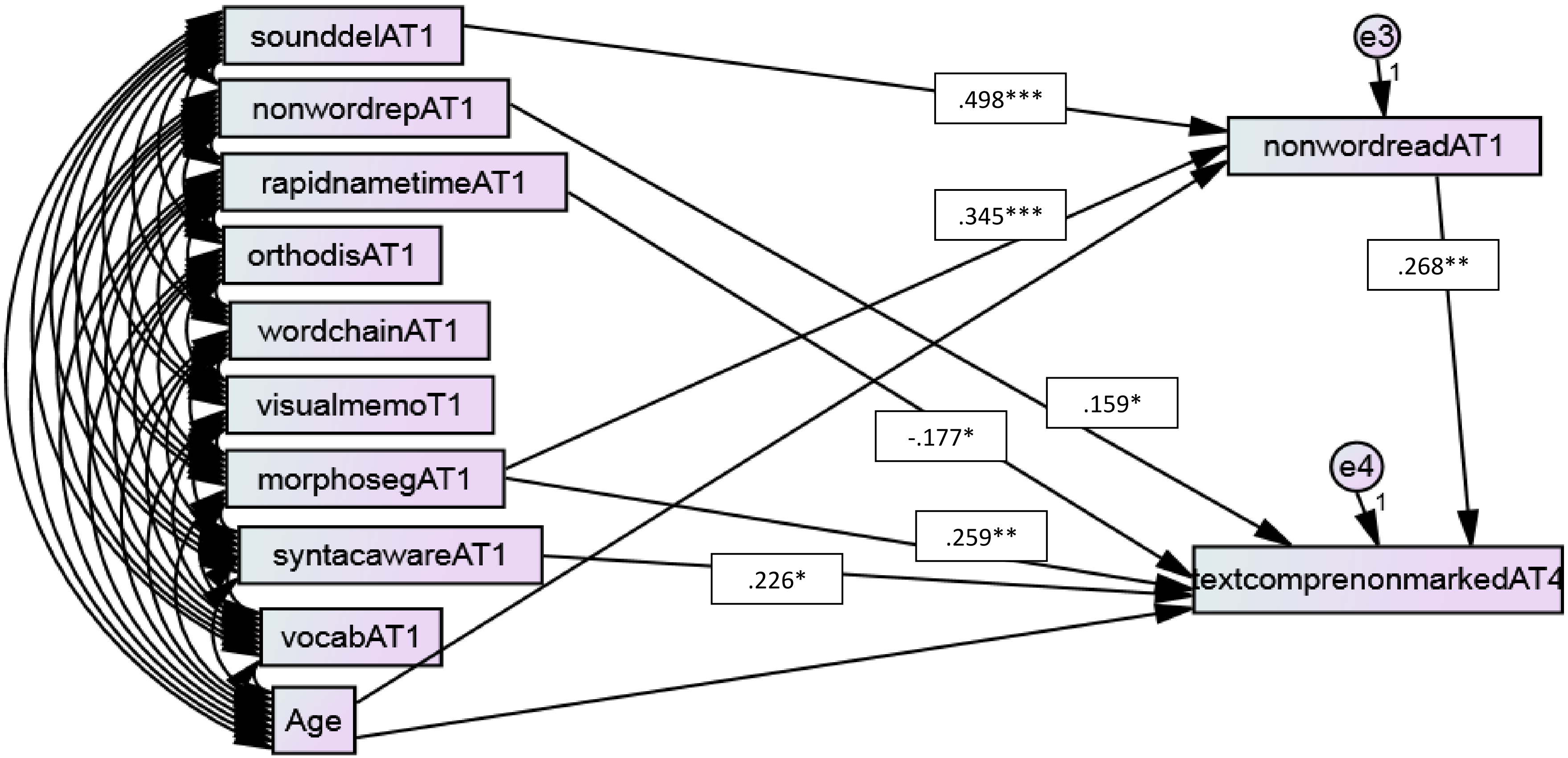
Path Analyses

Based on results from Word Reading Model in Chapter 5 (see Model 5.1), paths from Time 1 morphological segmentation and sound deletion to Time 1 Decoding (which was used as a mediator), then from Time 1 Decoding, RAN, Visual Memory and Syntactic Awareness to Time 1 word reading (which was also used as a mediator). We then added all possible paths from exogenous variables, in addition to decoding and word reading, to Non-Marked Text Comprehension. We controlled for age as discussed before. We allowed the Time 1 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (13) = 14.489, p=.340, CFI=.995, RMSEA=.040, PCLOSE=.503. To build a simpler model, we used variables with significant paths only (See Figure 6.5). Note that when deleting word reading (since its path to comprehension was insignificant), the model fit improved. The final model provided a good fit to the data set: $\chi 2$ (12) = 11.873, p=.456, CFI=1.000, RMSEA=.000, PCLOSE=.610. Unlike the regression results, the model shows that Time 1 decoding and morpho-syntactic skills are directly related to comprehension. It also shows that both RAN and non-word repetition, are directly related to non-marked-comprehension. The findings also indicate that Time 1 sound deletion is indirectly related to comprehension via decoding.

Another model was built using both word reading and morpho-syntactic skills (based on regression results) as mediators. The initial hypothesised model included paths from decoding, RAN, visual memory and syntactic awareness to word reading (based on results from Chapter 5). Then we added paths from all exogenous variables, in addition to word reading to both syntactic awareness and morphological segmentation. We also had a path from syntactic awareness to morphological segmentation. Finally, we had paths from exogenous variables in addition to word reading, syntactic awareness, and morphological segmentation to Non-Marked Text Comprehension. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (12) = 11.873, p=.456, CFI=.999, RMSEA=.028, PCLOSE=.485. To build a simpler model, we used variables with significant paths only (See Figure 6.6). The final model provided a good fit to the data set: $\chi 2$ (23) = 25.134, p=.343, CFI=.993, RMSEA=.036, PCLOSE=.559. Like the previous model, this model shows that decoding, morpho-syntactic skills, RAN, and non-word repetition, are directly related to non-marked comprehension. However, this model shows that vocabulary is indirectly related to comprehension via both syntactic awareness and morphological segmentation. It also shows that word reading is indirectly related to non-marked comprehension via syntactic awareness.

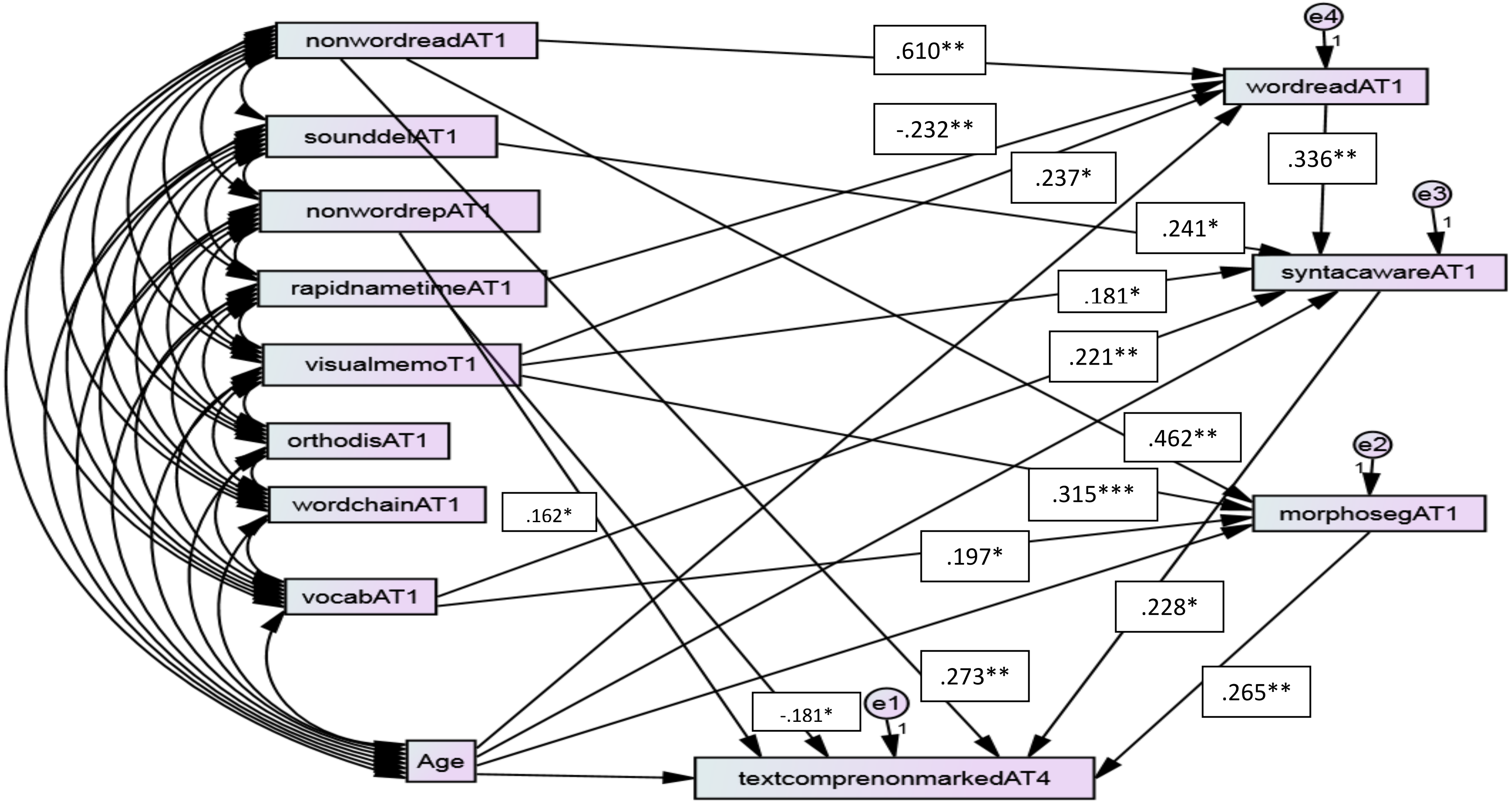
		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
Table 6.12 Regression analysis to investigate Time 1 predictors of Arabic Non-Marked Text Comprehension							
I	1	decoding	.345	.342	F(1,68)=35.494 p=.000	non-word reading	.151
	2	word reading	.461	.116	F(1,67)=14.379 p=.000		.132
II	1	word reading	.434	.430	F(1,68)=51.729 p=.000		
	2	decoding	.461	.027	F(1,67)=3.344 p=.72		
III	3	vocabulary	.493	.032	F(1,66)=4.103 p=.047		.053
	4	Morpho-syntactic awareness	.557	.065	F(2,64)=4.674 p=.013	syntactic awareness	.157
						morphological segmentation	.206
IV	3	Morpho-syntactic awareness	.551	.090	F(2,65)=6.516 p=.003		
	4	vocabulary	.557	.006	F(1,64)=.896 p=.347		
V	3	phonological awareness	.596	.039	F(3,61)=1.946 p=.132	sound deletion	.057
						rapid naming	-.135-
						non-word repetition	.143
	4	orthographic processing	.606	.010	F(3,58)=.507 p=.679	orthographic discrimination	.003
						word chain	.109
						visual memory	.052
VI	3	orthographic processing	.569	.012	F(3,61)=.544 p=.654		
	4	phonological awareness	.606	.037	F(3,58)=1.838 p=.150		

Figure 6.5 Path diagram to show the relations between skills from Time 1 variables to Time 4 Arabic non-marked reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

Figure 6.6 Path diagram to show the relations between skills from Time 1 variables to Time 4 Arabic non-marked reading comprehension.



Note. Numbers in the figure are standardised regression weights. ∗*p*=.05. ∗∗*p*=.01.∗∗∗*p* < .001

Time 2 Variables

The variance by measures of Time 2 on non-marked text comprehension was tested with a set of regressing analysis. For each set of these analyses, Time 4 non-marked text comprehension was the dependent variable. The independent variables were Time2 decoding skills, word reading, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.13 shows that when controlling for age, and decoding was entered before word reading it explained 38 % of variability while word reading explained 17%. When word reading was entered first, it explained 54% while decoding, similar to Time 1 results, became insignificant. When vocabulary was entered before orthographic processing, it explained 6% of variability, while orthographic processing was insignificant. When the order was reversed orthographic processing was still insignificant and vocabulary explained 6% variability. These results show that the main Time 2 predictor of Arabic non-marked text comprehension is word reading, in addition to vocabulary.

Path Analyses

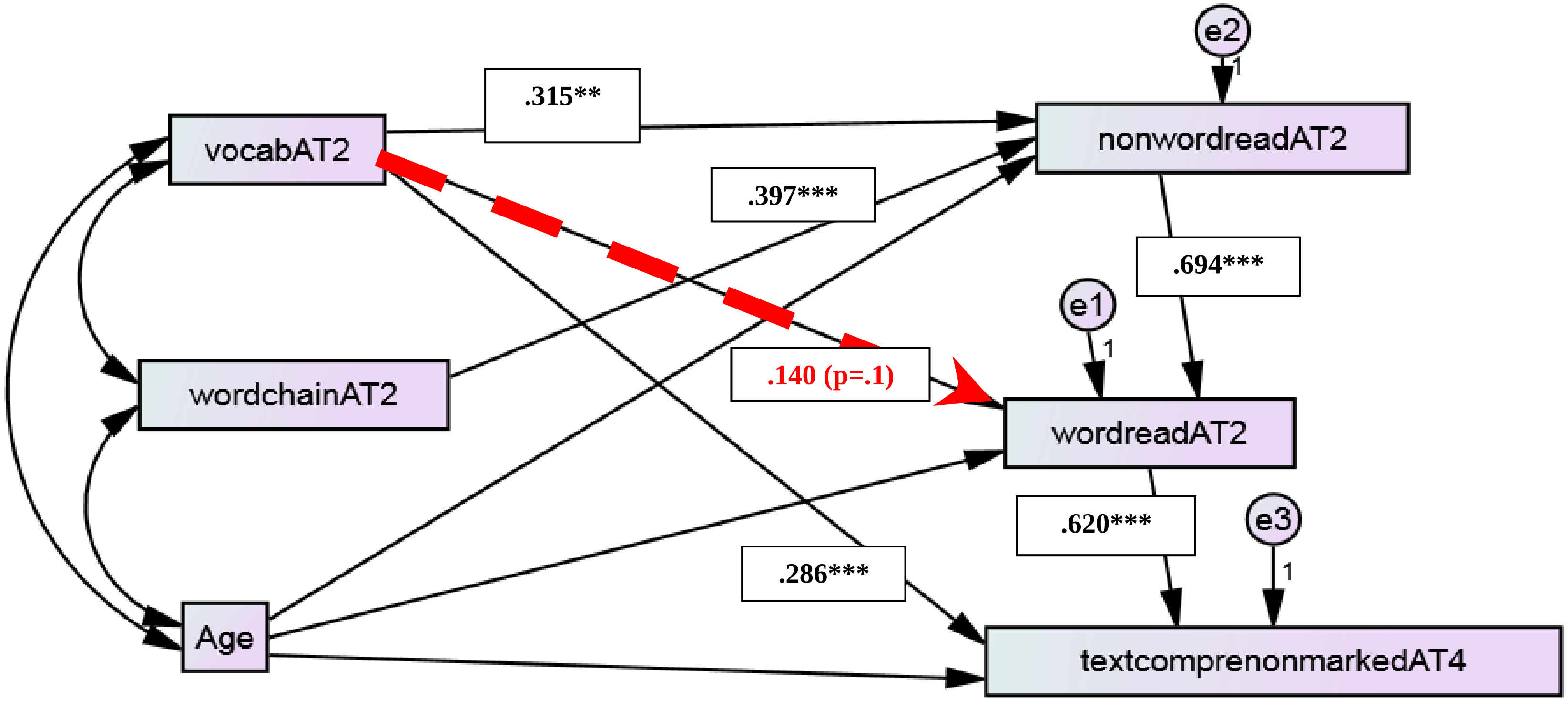
Based on regression results, the initial hypothesised model included paths from Time 2 vocabulary and word chain to Time 2 decoding and from Time 2 decoding and vocabulary to Time 2 word reading. Then we had all possible paths from Time 2 variables, in addition to Time 2 decoding and word reading to Time 4 non-marked text reading comprehension. We allowed the Time 2 (exogenous) variables to covary. Age was controlled for as discussed before. The initial hypothesised model did not provide a good fit to the data set: $\chi 2$ (1) = 1.957, p=.162, CFI=.993, RMSEA=.117, PCLOSE=.198. To build a simpler model, we used significant paths only, but the result was a model that was not quite fit $\chi 2$ (4) =6.132, p=.190, CFI=.985, RMSEA=.087, PCLOSE=.266). Therefore, we kept the path from vocabulary to word reading (which was significant at 0.1 level), and the model that resulted was a better fit (See Figure 6.7): $\chi 2$ (3) = 3.496, p=.321, CFI=.997, RMSEA=.049, PCLOSE=.398.

The model shows that vocabulary and word reading are directly related to Arabic non-marked text comprehension. The findings also indicate that Time 1 decoding is indirectly related to comprehension via word reading. Word chain also has a path via decoding and hence word reading.

Table 6.13 Regression analysis to investigate Time 2 predictors of Arabic Non-Marked Text Comprehension

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.384	.381	F(1,68) 42.053 p=.000	non-word reading	.076
	2	word reading	.556	.172	F(1,67)= 25.986 p=.000	.535	
II	1	word reading	.546	.543	F(1,68)= 81.316 p=.000		
	2	decoding	.556	.010	F(1,67)=1.535 p=.220		
III	3	vocabulary	.617	.061	F(1,66)= 10.445 p=.002	.276	
	4	orthographic processing	.621	.004	F(1,65)= .736 p=.394	word chain	.075
IV	3	orthographic processing	.561	.004	F(1,66)=.611 p=.437		
	4	vocabulary	.621	.061	F(1,65)= 10.441 p=.002		

Figure 6.7 Path diagram to show the relations between variables from Time 2 to Time 4 Arabic Non-Marked Reading Comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.
(*For regression weights highlighted in red, p.= .110).*

Time 3 Variables

Finally, the variance made by measures of Time 3 Arabic Non-Marked Reading Comprehension was tested with a set of regressing analysis. For each set of these analyses, Time 4 Arabic Non-Marked Reading was the dependent variable. The independent variables were Time 3 decoding skills, word reading, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.14 shows that, after controlling for age, when decoding was entered before word reading it explained 23% of variability while word reading explained 9.5%. When word reading was entered first, it explained 35% while decoding, similar to both Time 1 and Time 2 results, became insignificant. When vocabulary was entered before morpho-syntactic skills, it explained 5% of variability, while morpho-syntactic skills explained 14%. When the order was reversed morpho-syntactic skills explained 14 % and vocabulary became insignificant. When phonological processing was entered first, it explained 4% of variability and orthographic processing was insignificant. When the order was reversed, phonological processing explained 3.5%, and again orthographic processing was insignificant. It could be concluded then that the main Time 3 predictors of Arabic non-marked text comprehension are morpho-syntactic awareness, word reading, and phonological processing.

Path Analyses

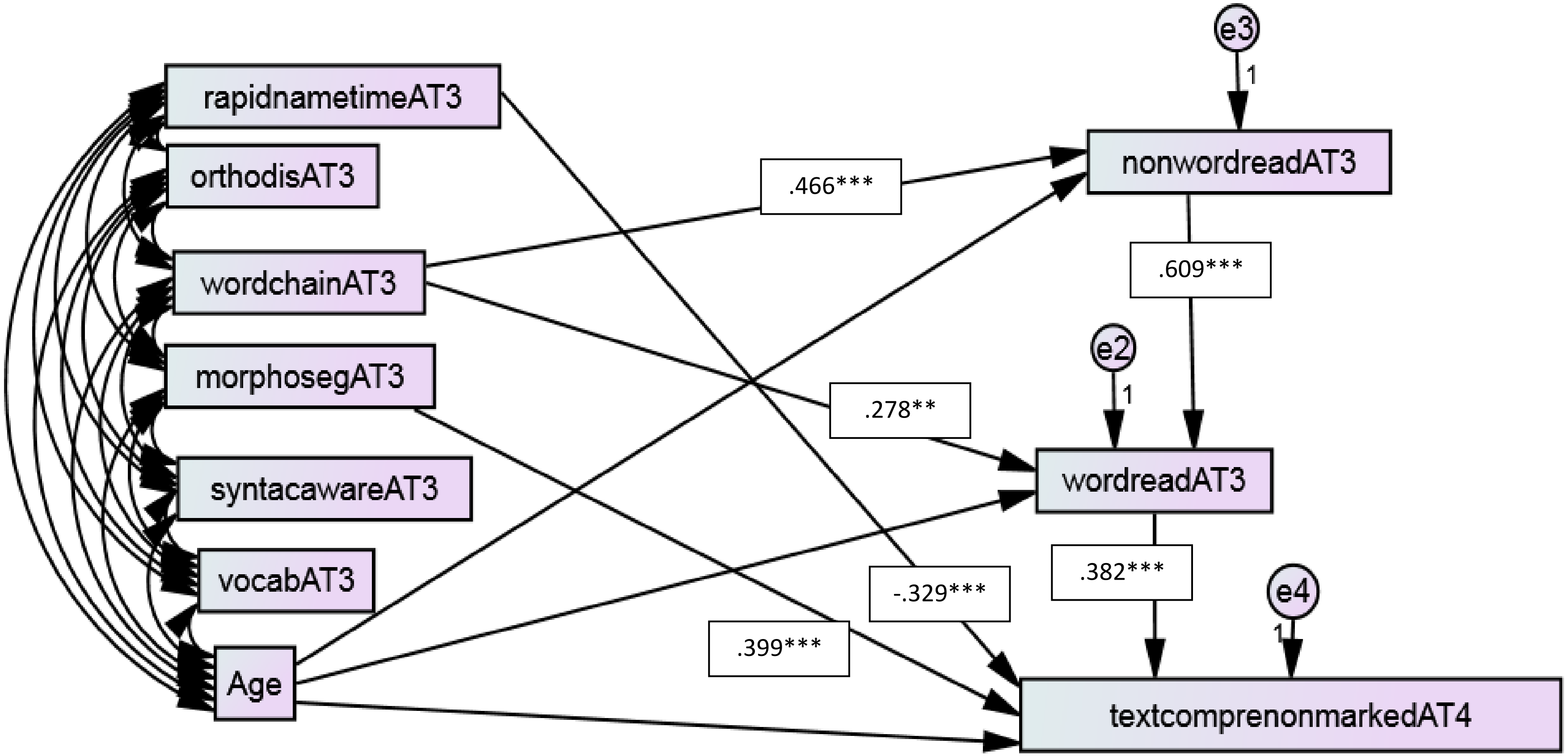
Based on Model 5.9, the first hypothesised model included paths from Time 3 word chain to Time 3 decoding, and from Time 3 decoding and word chain to Time 3 word reading. Finally we added paths from all Time 3 exogenous variables, in addition to decoding and word reading to Time 4 reading comprehension. Age was controlled for as previously discussed. We allowed the Time 3 (exogenous) variables to covary. The initial hypothesised model provided an acceptable fit to the data set: $\chi 2$ (10) = 14.951, p=.134, CFI=.978, RMSEA=.084, PCLOSE=.239. To build a simpler model, we used significant paths only. The final model showed a good model fit $\chi 2$ (15) = 20.840, p=.142, CFI=.974, RMSEA=.075, PCLOSE=.276 (See Figure 6.8). The model shows that RAN, morpho-syntactic awareness, and word reading are the only variables directly related to non-marked text comprehension.

Another model was tested which basically had morpho-syntactic skills as mediators, in addition to word reading. The initial hypothesised model had paths from word chain and decoding to word reading (based on previous results: see Chapter 5). Then we had paths from all exogenous variables to both morphological and syntactic processing. Finally, we had paths from all exogenous variables in addition to word reading, syntactic awareness, and morphological segmentation to non-marked text comprehension. Based on the modification indices, a path was added from syntactic awareness to morphological segmentation. We then added two paths from word reading to morphological segmentation and from word reading to syntactic awareness. The initial model provided a good fit to the data set: $\chi2$ (3) = 2.813, p=.421, CFI=1.000 RMSEA=.000, PCLOSE=.497. To build a simpler model we deleted insignificant paths, as discussed before. The final model had a good fit: $\chi2$ (16) = 15.053, p=.521, CFI=1.000 RMSEA=.000, PCLOSE=.690 (See Figure 6.9). The model shows that (like Model 6.8), that morphological segmentation, RAN, and word reading are directly related to non-marked text comprehension. However, the model also shows the indirect effect of other variables. Syntactic awareness and word chain both have indirect paths via morphological skills. Word reading, RAN, and vocabulary have indirect paths via syntactic awareness which in turn predicts morphological segmentation. Similarly, decoding and word chain predict word reading, which is indirectly related text comprehension as discussed.

Table 6.14 Regression analysis to investigate Time 3 predictors of Arabic Non-Marked Text Comprehension

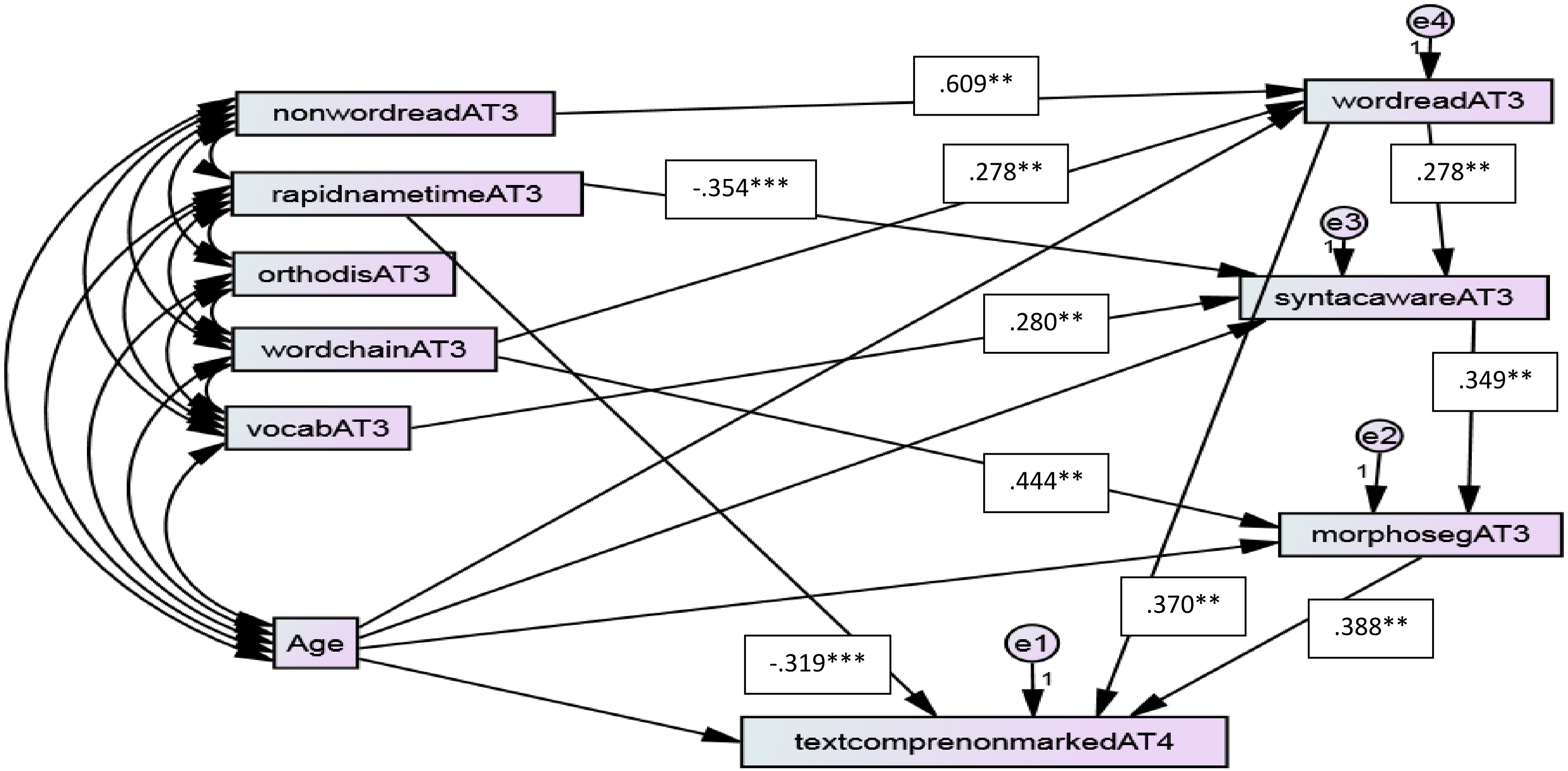
		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.281	.277	F(1,68)= 26.192 p=.000	non-word reading	.119
	2	word reading	.376	.095	F(1,67)= 10.170 p=.002	.109	
II	1	word reading	.357	.354	F(1,68)= 37.418 p=.000		
	2	decoding	.376	.018	F(1,67)= 1.952 p=.167		
III	3	vocabulary	.428	.052	F(1,66)= 6.046 p=.017	.075	
	4	Morpho-syntactic awareness	.566	.138	F(2,64)= 10.146 p=.000	syntactic awareness	.180
						morphological segmentation	.088
IV	3	Morpho-syntactic awareness	.563	.187	F(2,65)= 13.888 p=.000		
	4	vocabulary	.566	.003	F(1,64)=.466 p=.497		
V	3	phonological awareness	.609	.043	F(1,63)=6.990 p=.010	rapid naming	.045
	4	orthographic processing	.630	.021	F(2,61)=1.741 p=.184	orthographic discrimination	.062
						word chain	.097
VI	3	orthographic processing	.596	.030	F(2,62)= 2.298 p=.109		
	4	phonological awareness	.630	.035	F(1,61)=5.693 p=.020		

Figure 6.8 Path diagram to show the relations between skills from Time3 to Time 4 Arabic Non-Marked reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$.

Figure 6.9 Path diagram to show the relations between skills from Time3 to Time 4 Arabic Non-Marked reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

English Comprehension

Time 1 Variables

When investigating variance by measures of Time 1 on English Comprehension, a set of regressing analysis was conducted. For each set of these analyses, Time 4 outcome measure was the dependent variable. The independent variables were Time 1 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and Morpho-syntactic skills. The independent variables were entered in a set order. In each analysis, age was controlled for by being entered as step one. The results in Table 8.15 show that after controlling for age then decoding was entered before word reading it explained 42% of variability while word reading was insignificant. When word reading was entered first, it explained 37% while decoding explained 7%. When vocabulary was entered before morpho-syntactic awareness, it explained 3% of variability while morpho-syntactic awareness explained 11%. When the order was reversed morpho-syntactic awareness explained 14%, while vocabulary became insignificant. Both Time 1 orthographic processing and phonological awareness were insignificant. From this set of analyses, it could be concluded then that the main Time 1 predictors of English comprehension are, morpho-syntactic processing and decoding.

Path Analyses

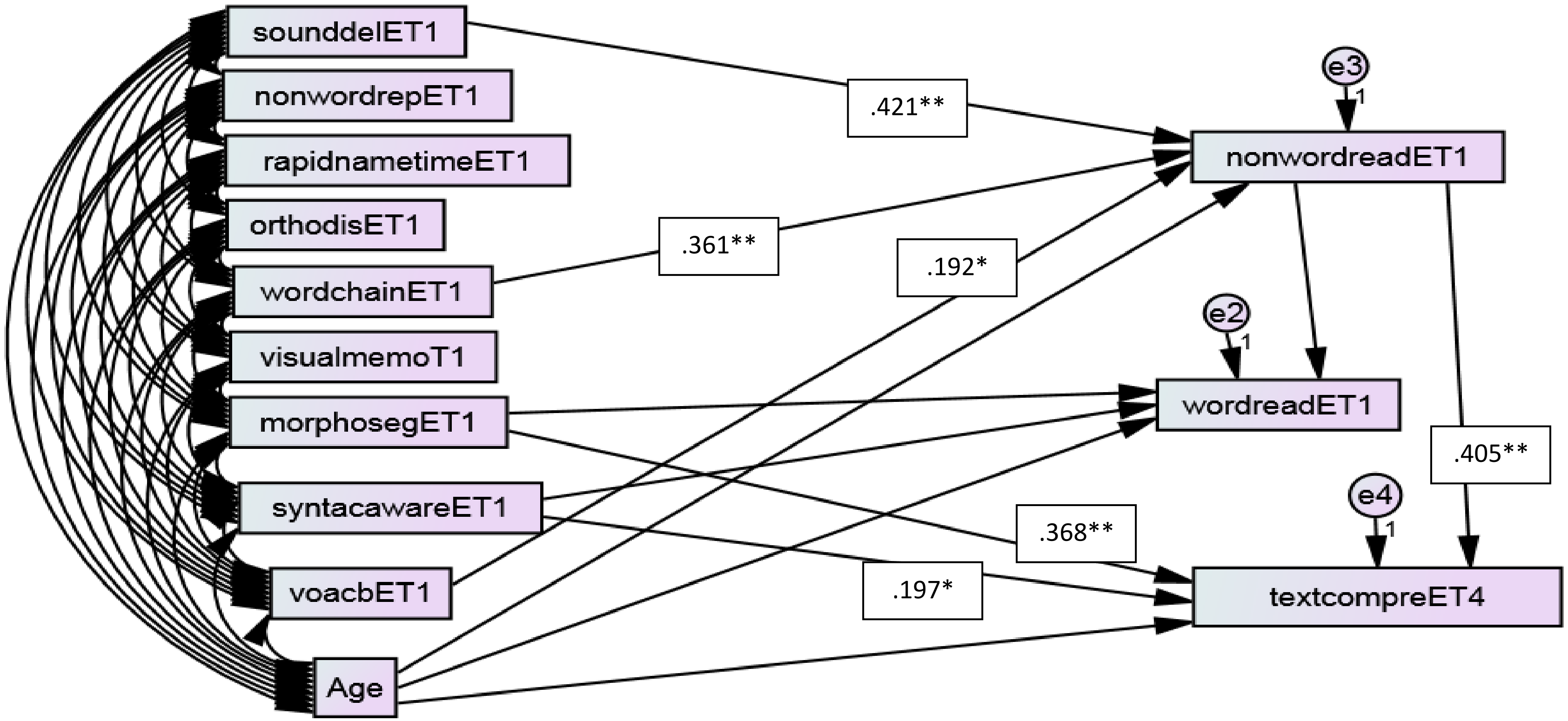
Based on results in Chapter 5 (see Model 5.2), the initial model included paths from Time 1 sound deletion, word chain and vocabulary to Time 1 decoding, and from Time 1 decoding and morpho-syntactic skills to Time 1 word reading, finally from all Time 1 exogenous skills in addition to Time 1 decoding and word reading to Time 4 reading comprehension. We allowed the Time 1 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (13) = 9.832, p=.708, CFI=1.000, RMSEA=.000, PCLOSE=.822. To build a simplified model, we used variables with significant paths only. The final model provided a good fit to the data set: $\chi 2$ (21) = 17.671, p=.670, CFI=1.000, RMSEA=.000, PCLOSE=.824. The model shows that Time 1 decoding and morpho-syntactic skills are directly related to English comprehension. It also shows that Vocabulary, Word chain and Sound Deletion are indirectly related to English Comprehension via decoding (see Figure 6.10).

Another model was built with decoding, word reading and morpho-syntactic skills as mediators. Based on Chapter 5 results (see Model 5.2), the initial hypothesised model included paths from Time 1 sound deletion, word chain and vocabulary to Time 1 decoding, and from Time 1 decoding and morpho-syntactic skills to Time 1 word reading. We then had paths from all Time 1 exogenous variables in addition to Time 1 decoding and word reading to Time 1 morpho-syntactic skills. We also added paths from morpho-syntactic skills to word reading. Finally we added paths from the previous variables to Time 4 English reading comprehension. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (9) = 9.832, p=.720, CFI=1.000, RMSEA=.000, PCLOSE=.813. To build a simplified model, we used variables with significant paths only. The final model provided a good fit to the data set: $\chi 2$ (29) = 26.567, p=.595, CFI=1.000, RMSEA=.000, PCLOSE=.797. Like the previous model, the model shows that Time 1 decoding and morpho-syntactic skills are directly related to English comprehension and that vocabulary, word chain, and sound deletion are indirectly related to English comprehension via decoding. However, it also shows that vocabulary (in addition to word reading, sound deletion, RAN and word chain) is indirectly related to English comprehension via morpho-syntactic skills (see Figure 6.11).

Table 6.15 Regression analysis to investigate Time 1 predictors of English Comprehension

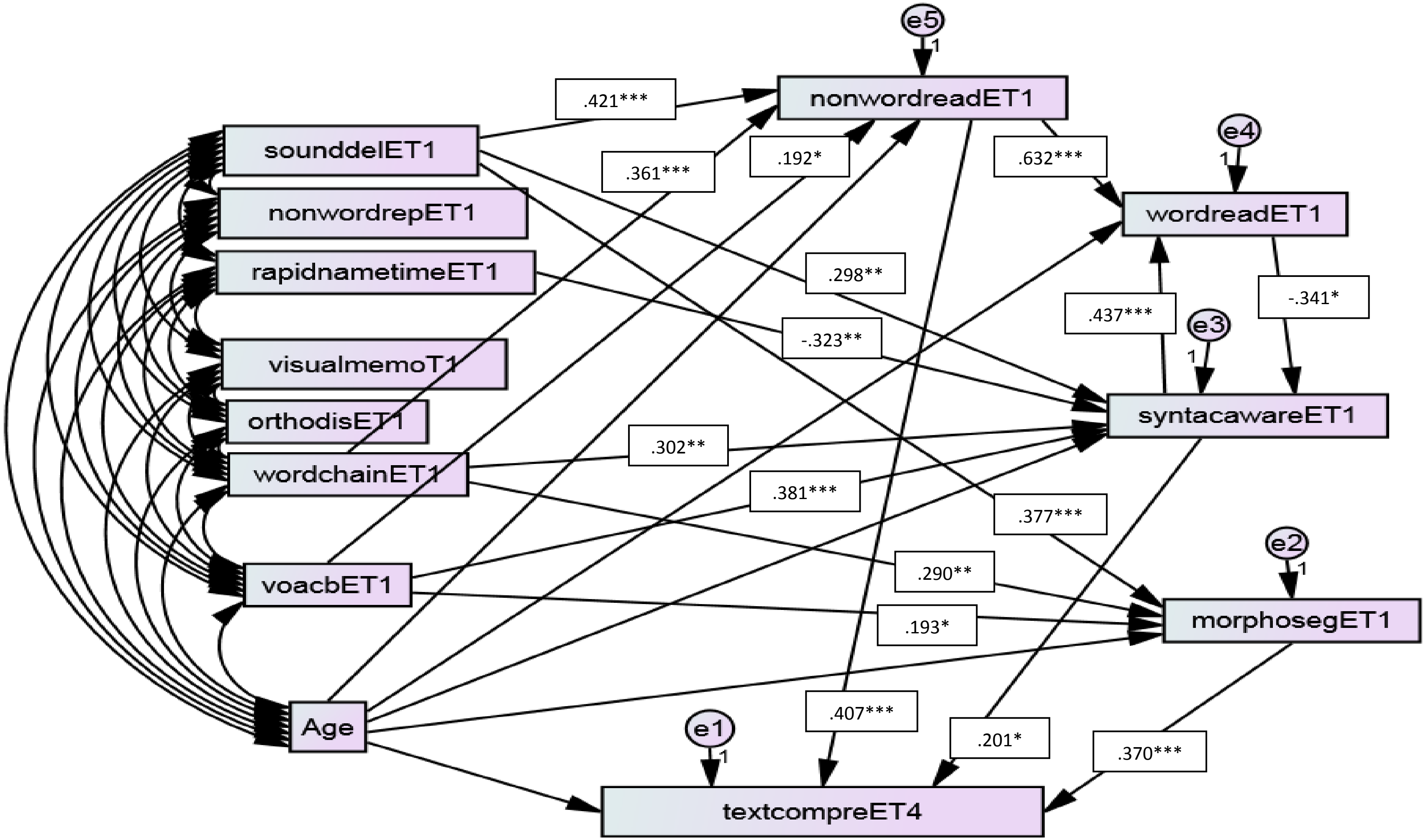
		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.434	.418	F(1,68)= 50.240 p=.000	non-word reading	.357
	2	word reading	.459	.025	F(1,67)= 3.128 p=.082	-.128-	
II	1	word reading	.388	.373	F(1,68)= 41.500 p=.000		
	2	decoding	.459	.070	F(8.725 p=.004		
III	3	vocabulary	.490	.031	F(1,66)= 4.011 p=.049	.103	
	4	Morpho-syntactic awareness	.603	.113	F(2,64)= 9.073 p=.000	syntactic awareness	.117
						morphological segmentation	.345
IV	3	Morpho-syntactic awareness	.597	.138	F(2,65)= 11.168 p=.000		
	4	vocabulary	.603	.005	F(1,64)=.853 p=.359		
V	3	phonological awareness	.615	.013	F(3,61=.667 p=.575	sound deletion	.059
						rapid naming	-.073-
						non-word repetition	.099
	4	orthographic processing	.640	.024	F(3,58)=1.305 p=.281	orthographic discrimination	.140
						word chain	.064
						visual memory	-.061-
VI	3	orthographic processing	.625	.022	F(3,61)= 1.197 p=.318		
	4	phonological awareness	.640	.015	F(3,58)=.797 p=.500		

Figure 6.10 Path diagram to show the relations between skills from Time 1 variables to Time 4 English reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001. (Only estimates that have effects on Comprehension are shown.)

Figure 6.11 Path diagram to show the relations between skills from Time 1 variables to Time 4 English reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$.

Time 2 Variables

The variance by measures of Time 2 on English Comprehension was tested with a set of regressing analysis. For each set of these analyses, Time 4 English Comprehension was the dependent variable. The independent variables were Time2 decoding skills, word reading, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The data in Table 8.16 show that, after controlling for age, when decoding was entered before word reading it explained 35 % of variability while word reading explained 11%. When word reading was entered first, it explained 45% while decoding became insignificant. Both vocabulary and orthographic processing were insignificant. These results show that the main Time 2 predictor of English Comprehension is word reading.

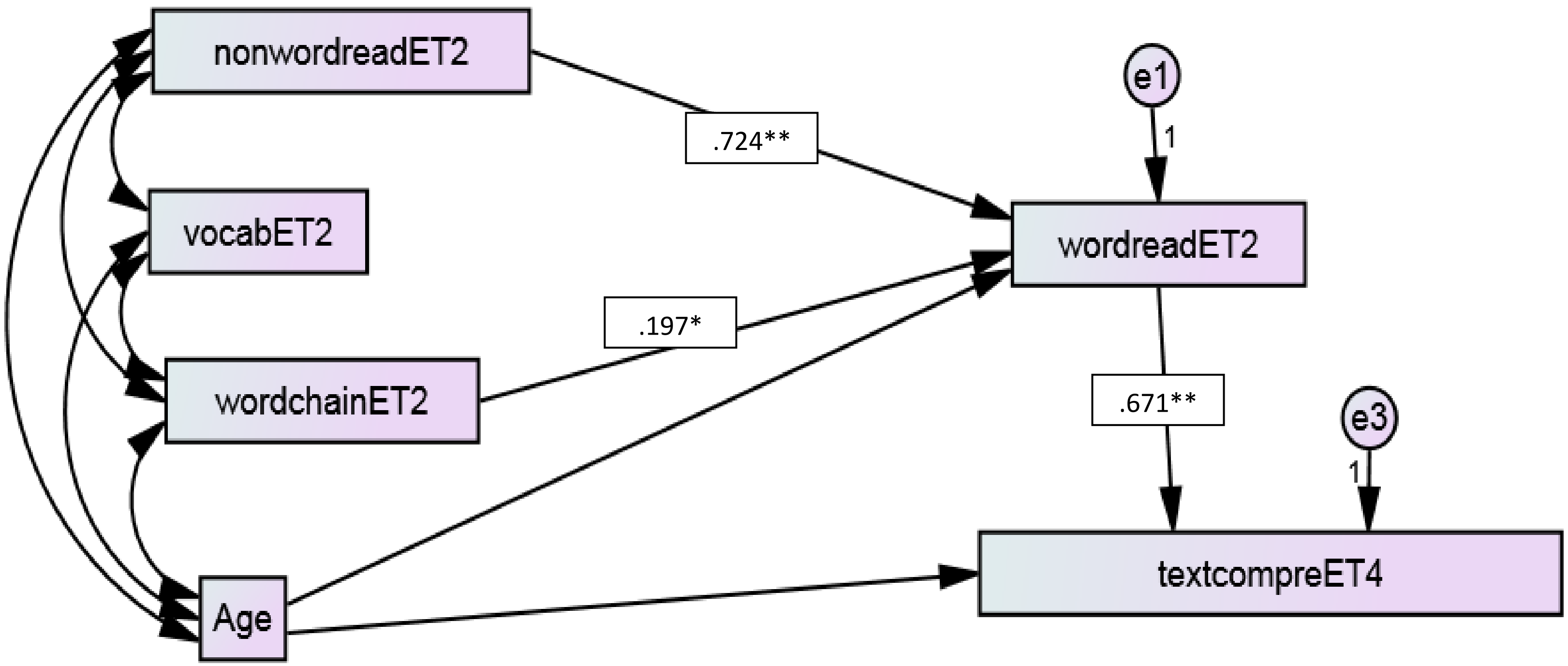
Path Analyses

When trying to build a model with decoding and word reading as mediators the model did not provide a good fit, even after deleting insignificant paths (initial model fit: $\chi 2$ (2) = 6.211, p=.045, CFI=.979, RMSEA=.173, PCLOSE=.070. Model fit after deleting insignificant paths: $\chi 2$ (5) = 9.840, p=.080, CFI=.976, RMSEA=.118, PCLOSE=.136). We tried to build a model with word reading only as a predictor. The first model included paths from Time 2 word chain and decoding, (based on regression results in Chapter 5), to Time 2 word reading and, from Time 2 decoding, vocabulary, word chain, in addition to Time 2 word reading to Time 4 reading comprehension. We allowed the Time 2 (exogenous) variables to covary. The initial hypothesised model did not provide a good fit to the data set: $\chi 2$ (4) = 5.806, p=.214, CFI=.994, RMSEA=.130, PCLOSE=.174. However, when we used significant paths only and the model that resulted was a good fit (See Figure 6.12). $\chi 2$ (4) = 5.712, p=.222, CFI=.991, RMSEA=.080, PCLOSE=.294. The path analysis shows that the main Time 2 predictor of English reading comprehension is word reading. Both decoding and word chain are indirectly related to comprehension via word reading.

Table 6.16 Regression analysis to investigate Time 2 predictors of English Comprehension

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.361	.345	F(1,68)= 36.749 p=.000	non-word reading	-.071-
	2	word reading	.466	.105	F(1,67)= 13.181 p=.001	.540	
II	1	word reading	.466	.450	F(1,68)= 57.322 p=.000		
	2	decoding	.466	.000	F(1,67)=.018 p=.893		
III	3	vocabulary	.472	.007	F(1,66)= .826 p=.367	.084	
	4	orthographic processing	.493	.020	F(1,65)=2.594 p=.112	word chain	.215
IV	3	orthographic processing	.487	.021	F(1,66)= 2.728 p=.103		
	4	vocabulary	.493	.006	F(1,65)=.724 p=.398		

Figure 6.12 Path diagram to show the relations between skills from Time 2 to Time 4 English reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ <

Time 3 Variables

Finally, the variance made by measures of Time 3 on English reading comprehension was tested with a set of regressing analysis. For each set of these analyses, Time 4 English reading comprehension was the dependent variable. The independent variables were Time 3 decoding skills, word reading, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.17 shows that, after controlling for age when decoding was entered before word reading it explained 35% of variability while word reading explained 7%. When word reading was entered first, it explained 42% while decoding became insignificant. After controlling for age, word reading and decoding, both vocabulary and morpho-syntactic skills added unique variance. When vocabulary was entered before morpho-syntactic skills, it explained 4% of variability, while morpho-syntactic skills explained 6%. When the order was reversed morpho-syntactic skills explained 7%, and vocabulary explained 3%. Both phonological processing and orthographic processing were insignificant. It could be concluded then that the main Time 3 predictors of English Reading Comprehension are morpho-syntactic processing, word reading, and vocabulary.

Path Analyses

Based on results in Chapter 5 (see Model 5.10), the initial model included paths from Time 3 word chain and syntactic awareness to Time 3 decoding; then from Time 3 decoding, word chain, morphological segmentation and vocabulary to Time 3 word reading. Finally, we added paths from all Time 3 exogenous variables in addition to Time 3 decoding and word reading to Time 4 reading comprehension. We allowed the Time 3 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (7) = 8.654, p=.278, CFI=.995, RMSEA=.058, PCLOSE=.393. To build a simplified model, we used significant paths only, the model showed a good fit $\chi 2$ (11) = 12.405, p=.334, CFI=.995, RMSEA=.043, PCLOSE=.483 (See Figure 6.13). The model shows that decoding, word chain, morphological segmentation, and vocabulary are directly related to English reading comprehension. However, it shows that word reading is not related to comprehension.

It also shows both syntactic awareness and word chains are indirectly related to comprehension via decoding.

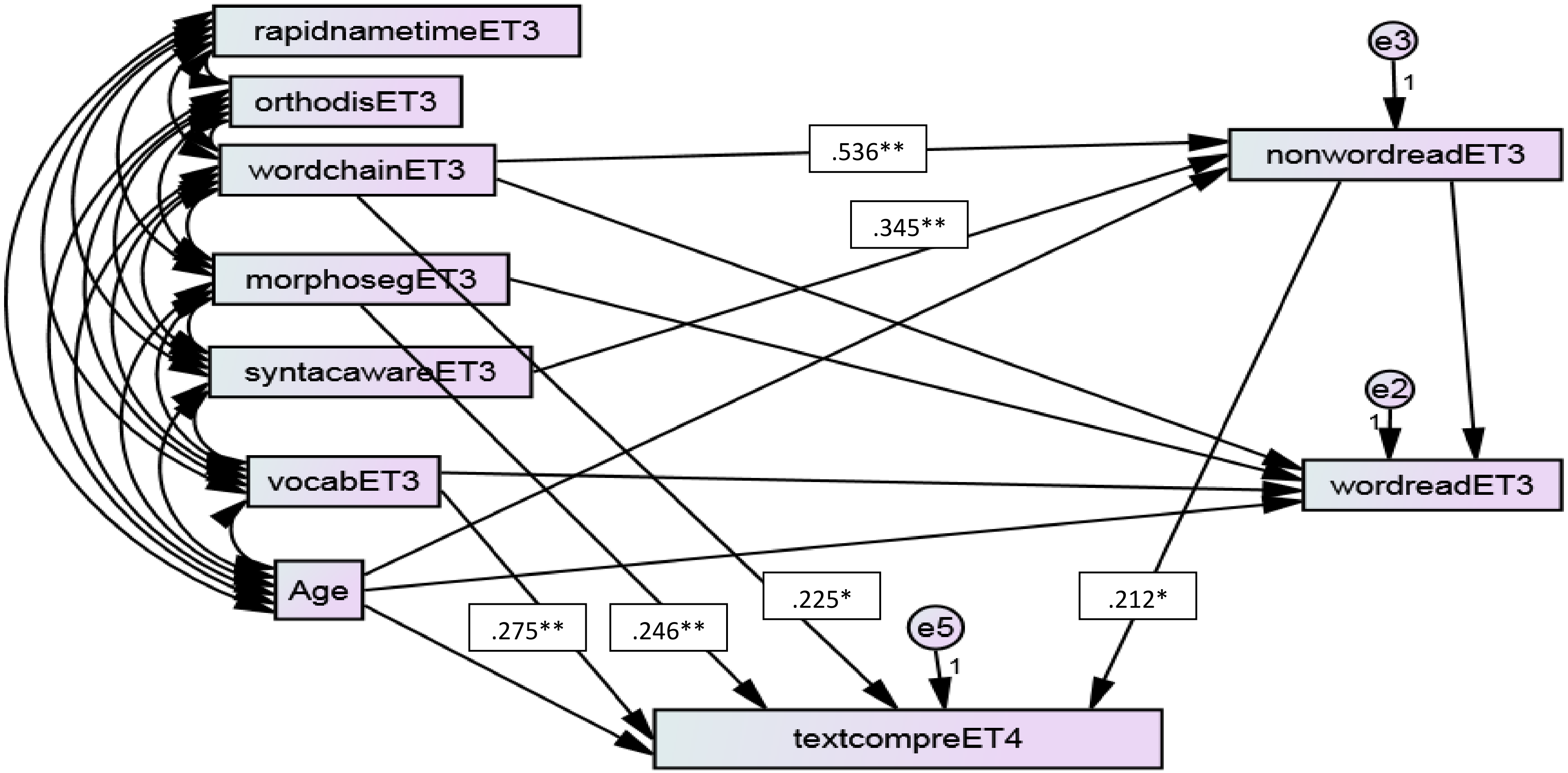
Another model with decoding, word reading and morpho-syntactic skills as mediators was built. The initial model had paths from RAN, orthographic discrimination, word chain and vocabulary to decoding, word reading, syntactic awareness, morphological segmentation (which were used as mediators) and to text comprehension. Paths were also added from the four mediators to comprehension. The initial model did not provide a good fit $\chi 2$ (7) = 66.164, p=.000, CFI=.805, RMSEA=.347, PCLOSE=.000.

Another model was built with paths from decoding, RAN, orthographic discrimination, word chain and vocabulary to word reading, syntactic awareness, morphological segmentation (which were used as mediators) and to text comprehension. Paths were added from word reading to both morphological segmentation and syntactic awareness. Paths were also added from the three mediators to comprehension. The initial model provided a poor fit $\chi 2$ (5) = 9.358, p=.096, CFI=.986, RMSEA=.112, PCLOSE=.157. After deleting insignificant paths, the final model provided a good fit to the data set $\chi 2$ (15) = 20.487, p=.154, CFI=.982, RMSEA=.072, PCLOSE=.293. (See Figure 6.14)

This final model shows that word chain, morphological segmentation, syntactic awareness, and vocabulary are directly related to English reading comprehension. Unlike the previous model, it also shows that word reading is related to comprehension via both morphological segmentation and syntactic awareness.

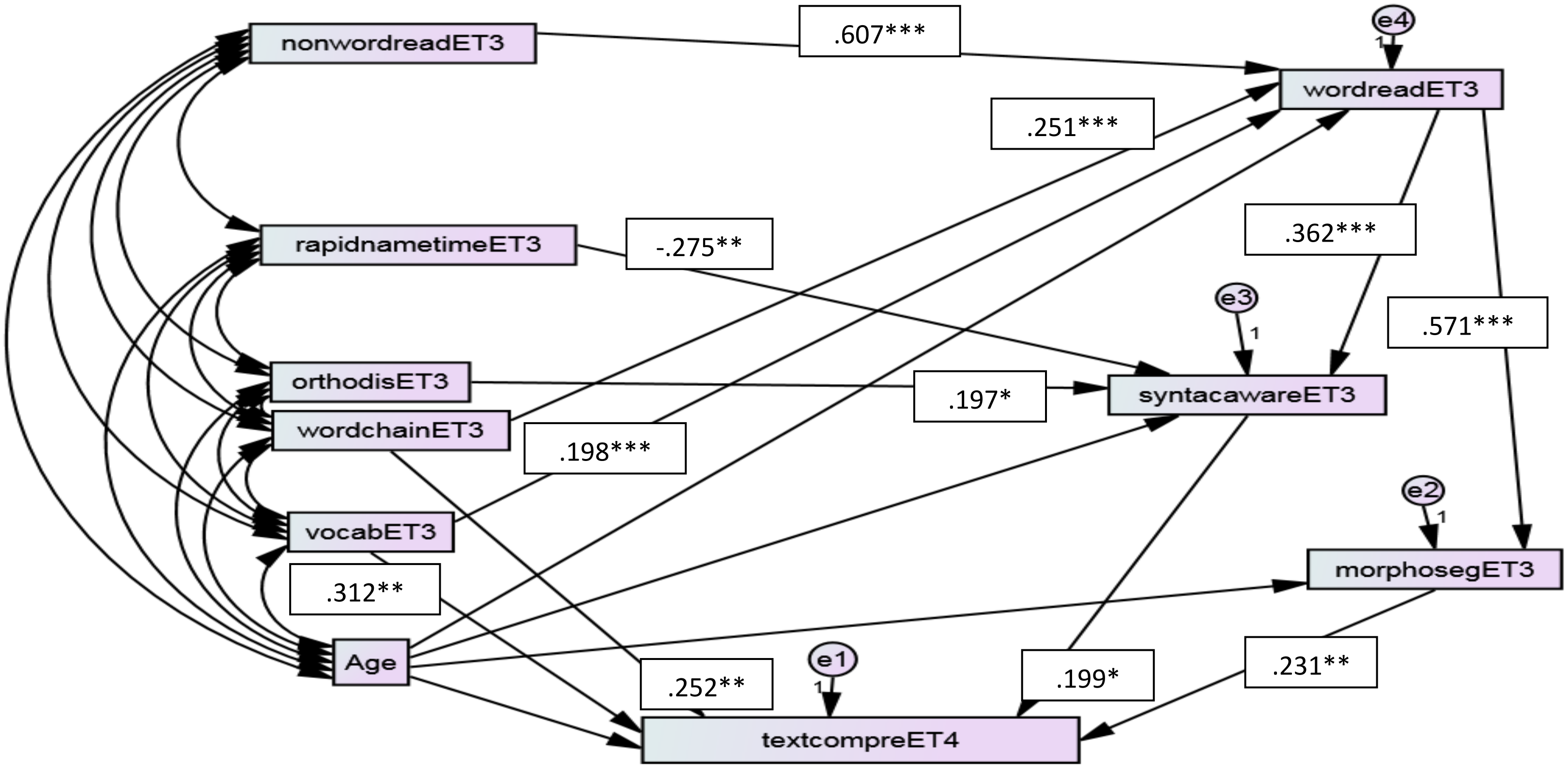
<table>
<tr><td colspan="8">Table 6.17 Regression analysis to investigate Time 3 predictors of English reading Comprehension</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>decoding</td><td>.368</td><td>.352</td><td>F(1,68)= 37.890
p=.000</td><td>non-word reading</td><td>.130</td></tr>
<tr><td>2</td><td>word reading</td><td>.439</td><td>.071</td><td>F(1,67)= 8.485
p=.005</td><td colspan="2">.033</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>word reading</td><td>.433</td><td>.418</td><td colspan="3">F(1,68)= 50.066
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.439</td><td>.006</td><td colspan="3">F(1,67)= .701
p=.406</td></tr>
<tr><td rowspan="3">III</td><td>3</td><td>vocabulary</td><td>.483</td><td>.044</td><td>F(1,66)= 5.636
p=.021</td><td colspan="2">.223</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.538</td><td rowspan="2">.055</td><td rowspan="2">F(2,64)= 3.819
p=.027</td><td>syntactic awareness</td><td>.121</td></tr>
<tr><td>morphological segmentation</td><td>.238</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>Morpho-syntactic awareness</td><td>.505</td><td>.067</td><td colspan="3">F(2,65)= 4.382
p=.016</td></tr>
<tr><td>4</td><td>vocabulary</td><td>.538</td><td>.033</td><td colspan="3">F(1,64)= 4.517
p=.037</td></tr>
<tr><td rowspan="3">V</td><td>3</td><td>phonological awareness</td><td>.539</td><td>.001</td><td>F(1,63)=.097
p=.756</td><td>rapid naming</td><td>.011</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">orthographic processing</td><td rowspan="2">.569</td><td rowspan="2">.030</td><td rowspan="2">F(2,61)=2.115
p=.129</td><td>orthographic discrimination</td><td>.103</td></tr>
<tr><td>word chain</td><td>.202</td></tr>
<tr><td rowspan="2">VI</td><td>3</td><td>orthographic processing</td><td>.569</td><td>.031</td><td colspan="3">F(2,62)= 2.195
p=.120</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.569</td><td>.000</td><td colspan="3">F(1,61)=.011
p=.916</td></tr>
</table>

Figure 6.13 Path diagram to show the relations between skills from Time3 to Time 4 English reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

Figure 6.14 Path diagram to show the relations between skills from Time 3 to Time 4 English reading comprehension.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$

Arabic Comprehension Fluency

Time 1 Variables

When investigating variance by measures of Time 1 on Arabic comprehension fluency, a set of regressing analysis was conducted. For each set of these analyses, Time 4 Arabic comprehension fluency was the dependent variable. The independent variables were Time 1 decoding skills, word reading, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The results are Table 6.17 show that when decoding was entered before word reading it explained 18% of variability while word reading explained 21%. When word reading was entered first, it explained 39% while decoding became insignificant. When vocabulary was entered before morpho-syntactic awareness it explained 8% of variance, but when entered after it explained 4%. Morpho-syntactic awareness was insignificant in both cases. When phonological awareness was entered before orthographic processing, both were insignificant, when the order was reversed orthographic processing explained 7% variability. From this set of analyses, it could be concluded then that the main Time 1 predictors of Arabic comprehension fluency are word reading, vocabulary, and orthographic processing.

Path Analyses

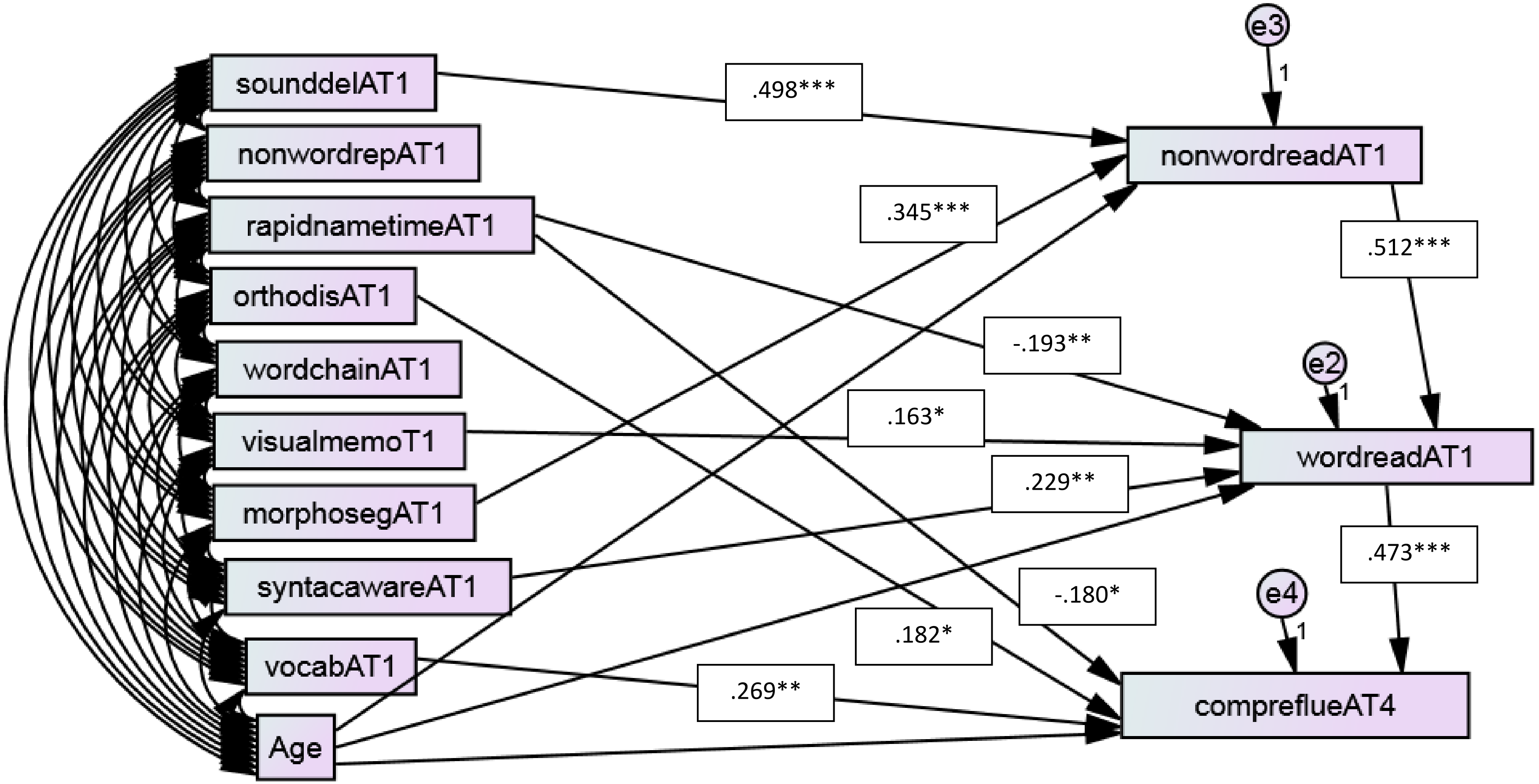
Based on Chapter 5 results (see Figure 5.15), the first model included paths from Time 1 sound deletion and morphological segmentation to Time 1 decoding; then from Time 1 decoding, RAN, visual memory and syntactic awareness to Time 1 word reading. Finally, we added paths from all exogenous variables, in addition to Time 1 word reading and decoding to Time 4 comprehension fluency. We allowed the Time 1 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model provided a good fit to the data set: $\chi2$ (13) = 14.489, p=.340, CFI=.995, RMSEA=.040, PCLOSE=.503. To build a simplified model, we used variables with significant paths only, (See Figure 6.15). The model provided a good fit to the data set: $\chi2$ (20) = 20.270, p=.441, CFI=.999, RMSEA=.014 PCLOSE=.639. The shows that word reading, vocabulary, RAN and orthographic discrimination are directly related to Arabic comprehension fluency. It also shows that

RAN, syntactic awareness, visual memory and decoding are indirectly related to Arabic comprehension fluency via word reading.

Table 6.18 Regression analysis to investigate Time 1 predictors of Arabic Comprehension Fluency

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.181	.180	F(1,68)= 14.935 p=.000	non-word reading	-.116-
	2	word reading	.394	.213	F(1,67)= 23.488 p=.000	.342	
II	1	word reading	.392	.391	F(1,68)= 43.789 p=.000		
	2	decoding	.394	.001	F(1,67)=.132 p=.718		
III	3	vocabulary	.468	.075	F(1,66)= 9.263 p=.003	.229	
	4	Morpho-syntactic awareness	.479	.011	F(2,64)=.688 p=.506	syntactic awareness	.102
						morphological segmentation	.152
IV	3	Morpho-syntactic awareness	.432	.039	F(2,65)=2.220 p=.117		
	4	vocabulary	.479	.047	F(1,64)=5.784 p=.019		
V	3	phonological awareness	.529	.050	F(3,61)=2.158 p=.102	sound deletion	.149
						rapid naming	-.144-
						non-word repetition	-.033-
	4	orthographic processing	.573	.043	F(3,58)=1.962 p=.130	orthographic discrimination	.223
						word chain	.077
						visual memory	-.082-
VI	3	orthographic processing	.544	.065	F(3,61)=2.890 p=.043		
	4	phonological awareness	.573	.029	F(3,58)=1.292 p=.286		

Figure 6.15 Path diagram to show the relations between skills from Time 1 variables to Time 4 Arabic comprehension fluency.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$.

Time 2 Variables

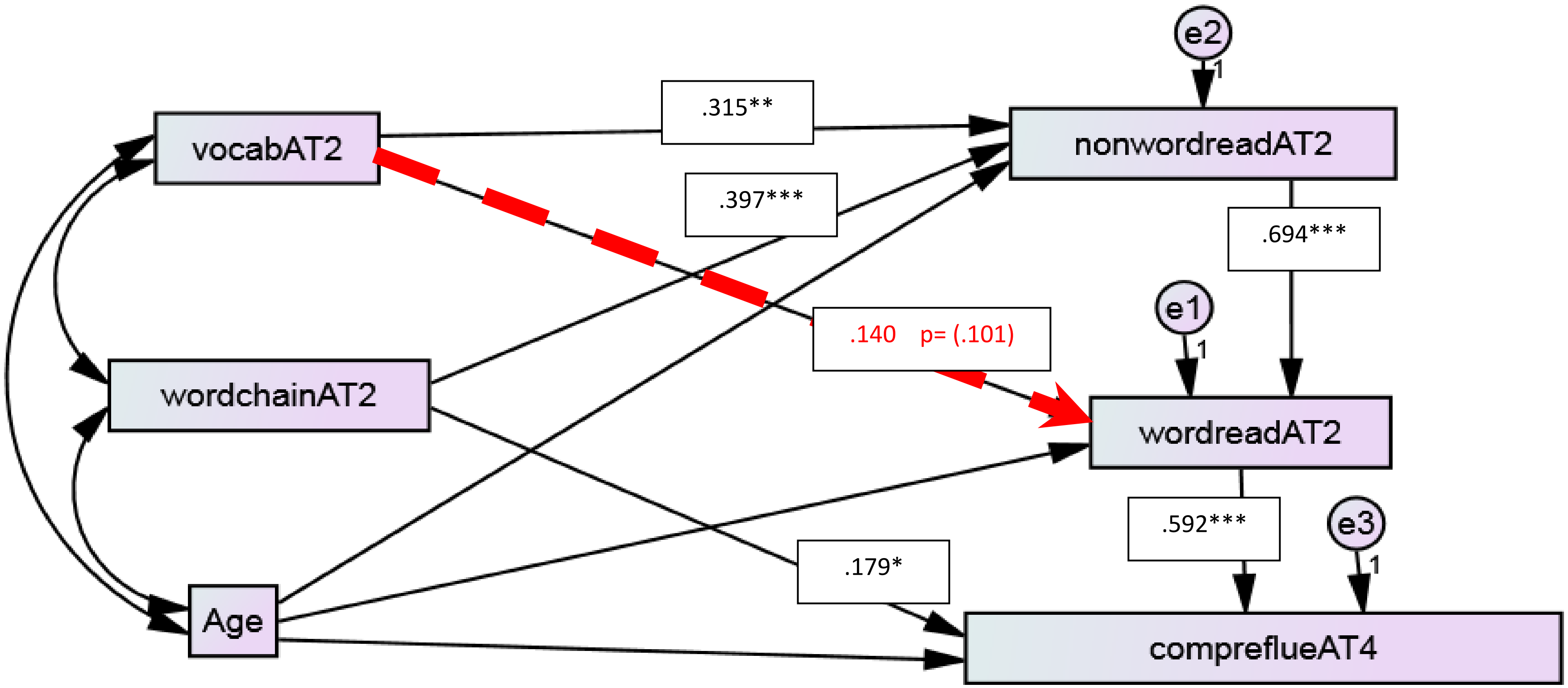
The variance by measures of Time 2 on Arabic Comprehension Fluency was tested with a set of regressing analysis. For each set of these analyses, Time 4 Arabic comprehension fluency was the dependent variable. The independent variables were Time 2 decoding skills, word reading, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.18 shows that when controlling for age and then decoding was entered before word reading it explained 31 % of variability while word reading explained 14%. When word reading was entered first, it explained 44% while decoding became insignificant. Both vocabulary and orthographic processing were insignificant. These results show that the main Time 2 predictor of Arabic comprehension fluency is word reading.

Path Analyses

Based on Chapter 5 results, the first model included paths from Time 2 vocabulary and word chain to Time 2 decoding; then from Time 2 decoding and vocabulary to Time 2 word reading. Finally, we added paths from all Time 2 exogenous variables, in addition to Time 2 word reading and decoding to Time 4 comprehension fluency. We allowed the Time 2 (exogenous) variables to covary. Age was controlled for as discussed before. The initial hypothesised model did not provide a good fit to the data set: $\chi2$ (1) = 1.957, p=.162, CFI=.992, RMSEA=.117, PCLOSE=.198. To build a simplified model, we tried to use significant paths only, but the model that resulted was not a good fit either: $\chi2$ (5) = 10.157 p=.071, CFI=.958, RMSEA=.121, PCLOSE=.123. However, when keeping the path from vocabulary to word reading (which was significant at level .1), the model provided a good fit to the data: $\chi2(3)$= 4.277, p=.233, CFI=.990, RMSEA=.078, PCLOSE=.304 (See Figure 6.16) The model shows that both word reading and word chain are directly related to comprehension fluency in Arabic. It also shows that Decoding is indirectly related to Arabic comprehension fluency via word reading. In addition, it shows that vocabulary is indirectly related to comprehension fluency via both decoding and word reading.

<table>
<tr><td colspan="8">Table 6.19 Regression analysis to investigate Time 2 predictors of Arabic Comprehension Fluency</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>decoding</td><td>.311</td><td>.310</td><td>F(1,68)= 30.664
p=.000</td><td>non-word reading</td><td>.063</td></tr>
<tr><td>2</td><td>word reading</td><td>.451</td><td>.140</td><td>F(1,67)= 17.086
p=.000</td><td colspan="2">.491</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>word reading</td><td>.443</td><td>.442</td><td colspan="3">F(1,68)= 53.965
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.451</td><td>.008</td><td colspan="3">F(1,67)= 1.021
p=.316</td></tr>
<tr><td rowspan="2">III</td><td>3</td><td>vocabulary</td><td>.465</td><td>.014</td><td>F(1,66)=1.697
p=.197</td><td colspan="2">.132</td></tr>
<tr><td>4</td><td>orthographic processing</td><td>.486</td><td>.020</td><td>F(1,65)=2.584
p=.113</td><td>word chain</td><td>.164</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>orthographic processing</td><td>.472</td><td>.020</td><td colspan="3">F(1,66)= 2.525
p=.117</td></tr>
<tr><td>4</td><td>vocabulary</td><td>.486</td><td>.014</td><td colspan="3">F(1,65)=1.767
p=.188</td></tr>
</table>

Figure 6.16 Path diagram to show the relations between skills from Time 2 variables to Time 4 Arabic comprehension fluency.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ <

Time 3 Variables

Finally, the variance made by measures of Time 3 on Arabic Comprehension Fluency was tested with a set of regressing analysis. For each set of these analyses, Time 4 Arabic Comprehension Fluency was the dependent variable. The independent variables were Time 3 decoding skills, word reading, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The data in Table 6.19 show that after controlling for age when decoding was entered before word reading, it explained 12% of variability while word reading explained 14%. When word reading was entered first, it explained 26% while decoding became insignificant. When vocabulary was entered before morpho-syntactic skills, it explained 5% of variance, while morpho-syntactic skills explained 14%. When the order was reversed, morpho-syntactic skills explained 20% while vocabulary became insignificant. When phonological processing was entered before orthographic processing, it explained 6% of variance, and orthographic processing was insignificant. When the order was reversed, both of them explained about 5% of variance. It could be concluded then that the main Time 3 predictors of Arabic comprehension Fluency are word reading, morpho-syntactic awareness, and phonological processing.

Path Analyses

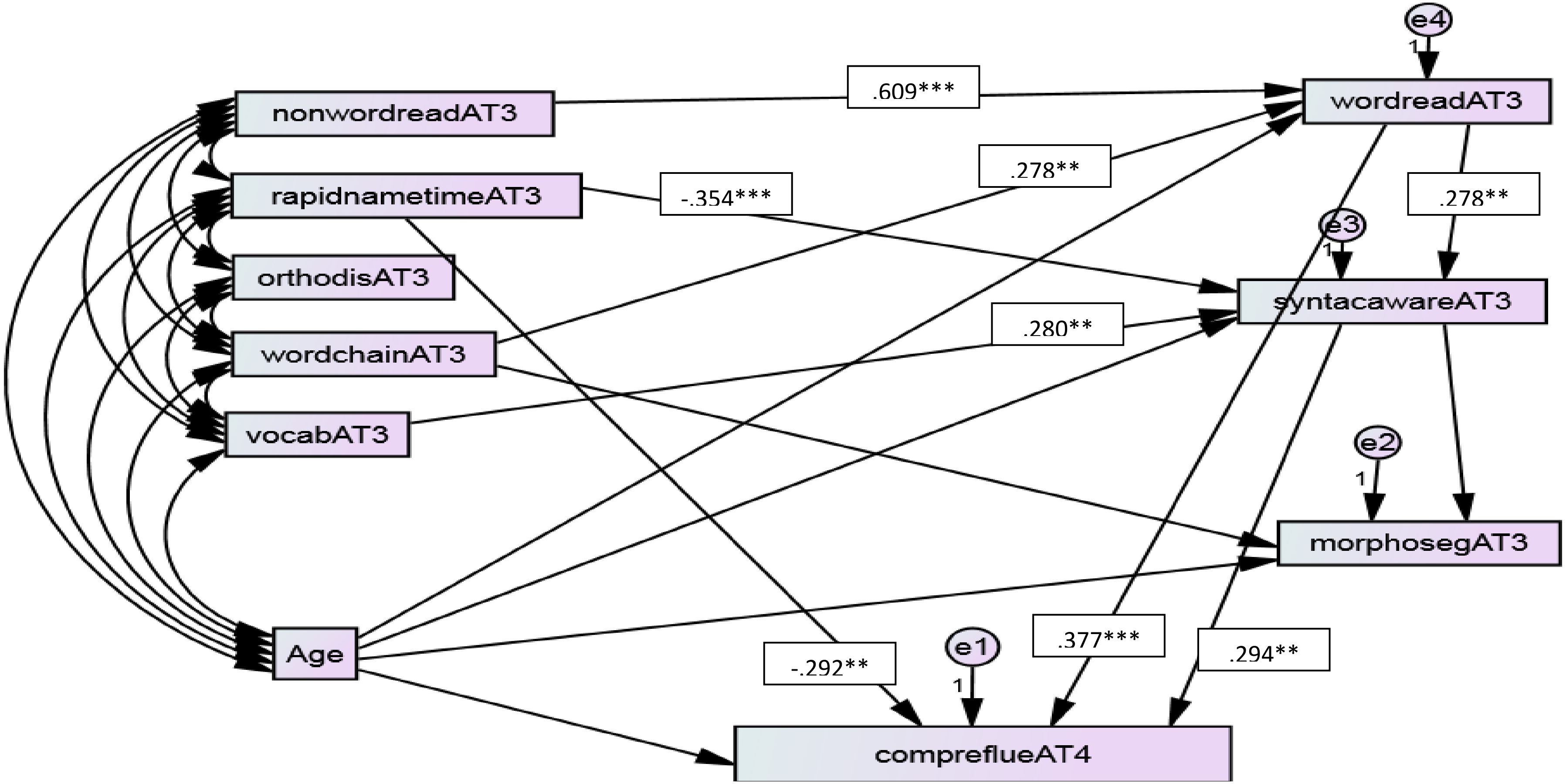
When trying to build a model with decoding and word reading as mediators, the model did not provide a good fit even after deleting insignificant paths: $\chi 2$ (15) = 23.694, p=.070, CFI=.959, RMSEA=.091, PCLOSE=.164. When trying to build a model with reading only as a mediator, the model did not provide a good fit either, even after deleting insignificant paths: $\chi 2$ (10) = 17.731, p=.060, CFI=.964, RMSEA=.105, PCLOSE=.127. Despite not being fit, the two models showed that word reading, syntactic awareness, and RAN were the only variables that had direct paths to comprehension fluency.

Another model was built with both word reading morpho-syntactic skills as mediators. The initial model included paths from word chain and decoding (based on previous results) to word reading, and from all exogenous variables in addition to word reading to both morphological segmentation and syntactic awareness. Finally, we had paths from all exogenous variables in addition to word reading, morphological segmentation and syntactic awareness to Time 4 comprehension fluency. We allowed the Time 3 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (3) = 2.813, p=.421, CFI=1.000, RMSEA=.000, PCLOSE=.497. To build a more simplified model, we used significant paths only. The final model provided a good fit: $\chi 2$ (16) = 17.906, p=.329, CFI=.965, RMSEA=.102, PCLOSE=.142. When using specification search in Amos, the first best model had a BCC_o=.000. It provided a good fit to the data. $\chi 2$ (6) = 6.425, p=.377, CFI=.991, RMSEA=.041, PCLOSE=.509 (See Figure 6.17). The model shows that (like previous models) word reading, syntactic awareness and RAN are directly related to Arabic comprehension fluency. However, this model shows that vocabulary is indirectly related to Arabic comprehension fluency via syntactic awareness.

Table 6.20 Regression analysis to investigate Time 3 predictors of Arabic Comprehension Fluency

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.124	.123	F(1,68)= 9.539 p=.003	non-word reading	-.169-
	2	word reading	.268	.144	F(1,67)= 13.196 p=.001	.349	
II	1	word reading	.267	.266	F(1,68)= 24.632 p=.000		
	2	decoding	.268	.001	F(1,67)= .130 p=.720		
III	3	vocabulary	.322	.054	F(1,66)=5.257 p=.025	-.028-	
	4	Morpho-syntactic awareness	.466	.144	F(2,64)=8.606 p=.000	syntactic awareness	.228
						morphological segmentation	.151
IV	3	Morpho-syntactic awareness	.465	.197	F(2,65)= 11.950 p=.000		
	4	vocabulary	.466	.001	F(1,64)=.108 p=.744		
V	3	phonological awareness	.540	.075	F(1,63)=10.248 p=.002	rapid naming	-.278-
	4	orthographic processing	.566	.025	F(2,61)=1.771 p=.179	orthographic discrimination	.154
						word chain	.118
VI	3	orthographic processing	.520	.054	F(2,62)= 3.482 p=.037		
	4	phonological awareness	.566	.046	F(1,61)=6.461 p=.014		

Figure 6.17 Path diagram to show the relations between skills from Time 3 variables to Time 4 Arabic comprehension fluency.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$. (Only estimates that have effect on Comprehension Fluency are shown)

English Comprehension Fluency

Time 1 Variables

When investigating variance by measures of Time 1 on English Comprehension Fluency, a set of regressing analysis was conducted. For each set of these analyses, Time 4 outcome measure was the dependent variable. The independent variables were Time 1 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The independent variables were entered in a set order. In each analysis, age was controlled for by being entered as step one. The results in Table 6.1.show that after controlling for age, when decoding was entered before word reading it explained 16% of variability while word reading was insignificant. When word reading was entered first, it explained 18% while decoding became insignificant. The rest of the variables were insignificant except for orthographic processing which explained 9% variability when entered after phonological awareness. From this set of analyses, it could be concluded then that the main Time 1 predictor of English comprehension fluency is word reading and orthographic processing. Neither word reading nor decoding added any unique variance when one of them was entered after the other. To investigate these relationships, a path analysis was conducted.

Path Analyses

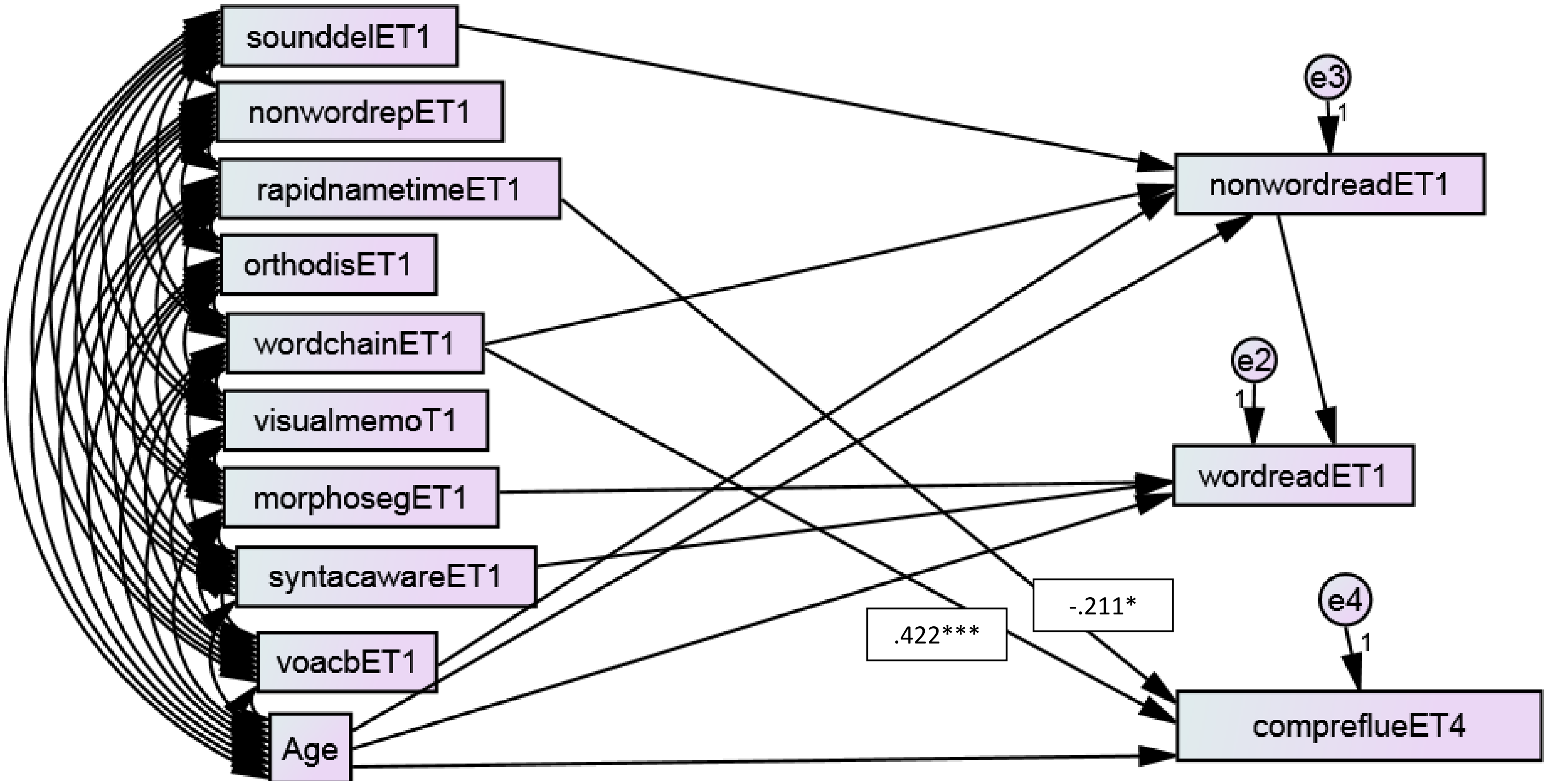
Based on results in Chapter 5, (see Model 5.2), the initial model included paths from sound deletion and word chain to decoding; and from decoding and morpho-syntactic skills to word reading. Finally, we added paths from all Time 1 exogenous variables, in addition to word reading and decoding to Time 4 comprehension fluency. We allowed the Time 1 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (13) = 9.832, p=.708, CFI=1.000, RMSEA=.000, PCLOSE=.822. To build a simplified model, we used significant paths only, (See Figure 6.18). The model provided a good fit to the data set: $\chi 2$ (22) = 16.073, p=.812, CFI=1.000, RMSEA=.000, PCLOSE=.915. The model confirms that Time 1 word chain predicts English comprehension fluency. It also shows that RAN is directly related to comprehension fluency.

A model was built with word chain, syntactic awareness and morphological segmentation as mediators. The initial model had paths from decoding, sound deletion, non-word repetition, RAN, orthographic discrimination, visual memory and vocabulary to word chain, syntactic awareness and morphological segmentation (which were used as mediators). Then, paths were added from syntactic awareness and morphological segmentation to word chain. Finally, paths were added from RAN (based on the previous model), vocabulary, word chain, syntactic awareness and morphological segmentation to comprehension fluency. The initial model provided a good fit to the data set: $\chi 2$ (6) = 5.156, p=.524, CFI=1.000, RMSEA=.000, PCLOSE=.628. After deleting insignificant paths, the final model provided a good fit as well: $\chi 2$ (24) = 21.463, p=.611, CFI=1.000, RMSEA=.000, PCLOSE=.793 (See Figure 6.19). Like the previous model, this one shows that both word chain and RAN are directly related to English comprehension fluency. However, this model shows that morpho-syntactic processing and decoding are indirectly related to English comprehension fluency via word chain and that vocabulary is indirectly related to it via morpho-syntactic processing. It is worth noting that when trying to build a model with word reading as a mediator, it did not have any direct or indirect relationship with comprehension fluency (even via word chain as will be noticed in Time 3 results later in this chapter).

Table 6.21 Regression analysis to investigate Time 1 predictors of English Comprehension Fluency

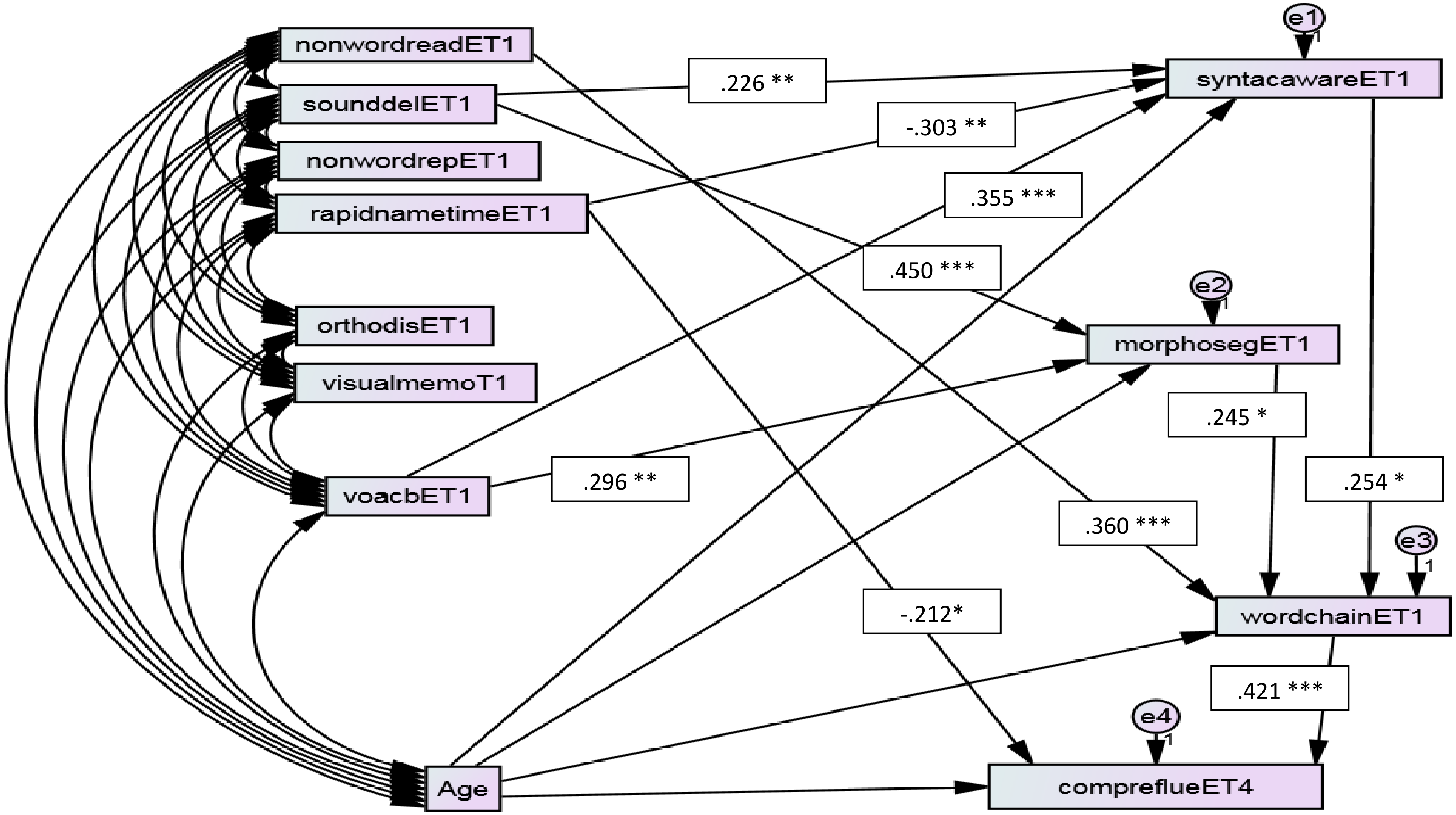
		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.162	.157	F(1,68)= 12.744 p=.001	non-word reading	-.059-
	2	word reading	.191	.029	F(1,67)= 2.387 p=.127	.034	
II	1	word reading	.180	.175	F(1,68)= 14.496 p=.000		
	2	decoding	.191	.011	F(1,67)=.913 .343		
III	3	vocabulary	.212	.022	F(1,66)= 1.811 p=.183	.202	
	4	Morpho-syntactic awareness	.224	.011	F(2,64)=.465 p=631	syntactic awareness	-.215-
						morphological segmentation	.008
IV	3	Morpho-syntactic awareness	.209	.018	F(2,65)= .727 p=.487		
	4	vocabulary	.224	.015	F(1,64)= 1.252 p=.267		
V	3	phonological awareness	.268	.045	F(3,61)= 1.237 p=304	sound deletion	.250
						rapid naming	-.136-
						non-word repetition	.119
	4	orthographic processing	.359	.090	F(3,58)= 2.721 p=.053	orthographic discrimination	.005
						word chain	.390
						visual memory	-.061-
VI	3	orthographic processing	.301	.077	F(3,61)= 2.243 p=.92		
	4	phonological awareness	.359	.058	F(3,58)=1.738 p=.169		

Figure 6.18 Path diagram to show the relations between skills from Time 1 variables to Time 4 English comprehension fluency.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001. (Only estimates that have effect on Comprehension Fluency are shown.)

Figure 6.19 Path diagram to show the relations between skills from Time 1 variables to Time 4 English comprehension fluency



Note. Numbers in the figure are standardised regression weights. $*p=.05$. $**p=.01$.$***p < .001$

Time 2 Variables

The variance by measures of Time 2 on English comprehension fluency was tested with a set of regressing analysis. For each set of these analyses, Time 4 English Comprehension Fluency was the dependent variable. The independent variables were Time2 decoding skills, word reading, vocabulary and orthographic processing. Table 6.21 shows that after controlling for age when decoding was entered before word reading, it explained 25 % of variability while word reading explained 10%. When word reading was entered first, it explained 35% while decoding became insignificant. Both vocabulary and orthographic processing were insignificant. These results show that the main Time 2 predictor of English comprehension fluency is word reading.

Path Analyses

When trying to build a model with both word reading and decoding as mediators, the model did not provide a good fit to the data set, even after deleting insignificant paths: $\chi 2$ (4) = 6.060, p=.195, CFI=.989, RMSEA=.086, PCLOSE=.272. When trying to build a model using word reading only as a mediator, the model provided the same fit. The two models showed that the sole variable directly related to English comprehension fluency was word reading.

<table>
<tr><th colspan="8">Table 6.22 Regression analysis to investigate Time 2 predictors of English Comprehension Fluency</th></tr>
<tr><th colspan="2"></th><th>Variables</th><th>R^2</th><th>R^2 change</th><th>Sig R^2 change</th><th colspan="2">Final Beta</th></tr>
<tr><td rowspan="2">I</td><td>1</td><td>decoding</td><td>.257</td><td>.252</td><td>F(1,68)= 23.043
p=.000</td><td>non-word reading</td><td>-.148-</td></tr>
<tr><td>2</td><td>word reading</td><td>.352</td><td>.095</td><td>F(1,67)= 9.832
p=.003</td><td colspan="2">.500</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>word reading</td><td>.352</td><td>.347</td><td colspan="3">F(1,68)= 36.356
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.352</td><td>.000</td><td colspan="3">F(1,67)=.030
p=.863</td></tr>
<tr><td rowspan="2">III</td><td>3</td><td>vocabulary</td><td>.354</td><td>.002</td><td>F(1,66)=.245
p=.622</td><td colspan="2">.046</td></tr>
<tr><td>4</td><td>orthographic processing</td><td>.387</td><td>.032</td><td>F(1,65)=3.423
.069</td><td>word chain</td><td>.272</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>orthographic processing</td><td>.385</td><td>.033</td><td colspan="3">F(1,66)= 3.540
p=.064</td></tr>
<tr><td>4</td><td>vocabulary</td><td>.387</td><td>.002</td><td colspan="3">F(1,65)=.181
p=.672</td></tr>
</table>

Time 3 Variables

Finally, the variance made by measures of Time 3 on English comprehension fluency was tested with a set of regressing analysis. For each set of these analyses, Time 4 English comprehension fluency was the dependent variable. The independent variables were Time 3 decoding skills, word reading, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.22 shows that, after controlling for age, when decoding was entered before word reading it explained 21% of variability while word reading explained 8%. When word reading was entered first, it explained 29% while decoding became insignificant. Vocabulary, morpho-syntactic skills, and phonological processing were insignificant. Orthographic processing explained about 12% of variance. It could be concluded then that the main Time 3 predictors of English comprehension fluency are word reading and orthographic processing.

Path Analyses

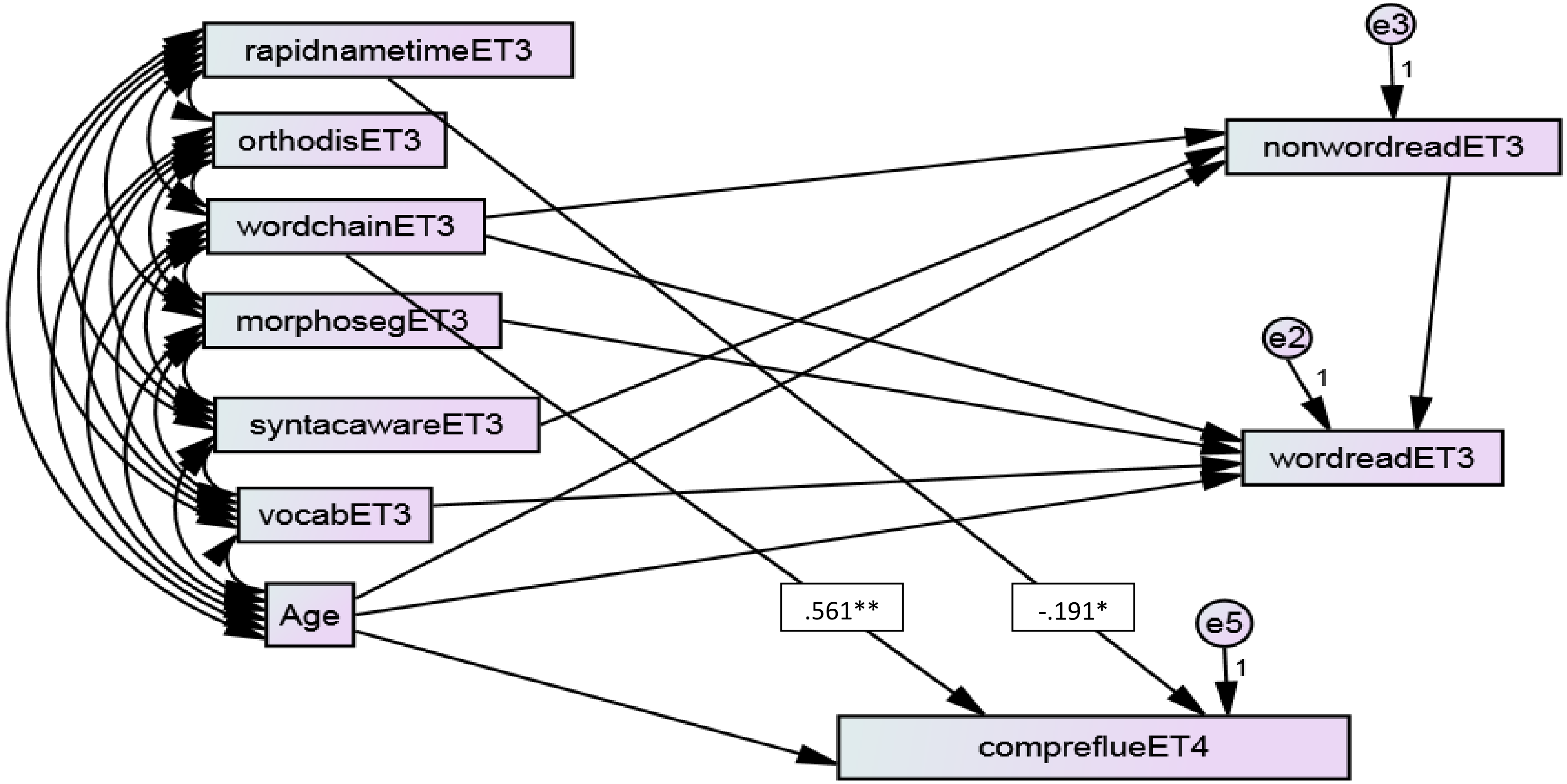
Based on results from Chapter 5 (see Table 5.10); the first model included paths from Time 3 word chain and syntactic awareness to Time 3 decoding, then from Time 3 decoding, word chain, morphological segmentation, and vocabulary, to Time 3 word reading. Finally, we added paths from all Time 3 exogenous variables, in addition to decoding and word reading to Time 4 reading comprehension. We allowed the Time 3 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (7) = 8.654, p=.278, CFI=.994, RMSEA=.058, PCLOSE=.393. To build a simplified model, we used significant paths only; the model showed was a good fit $\chi 2$ (13) = 13.898, p=.381, CFI=.997, RMSEA=.031, PCLOSE=.544 (See Figure 6.20). The model shows that word chain and RAN are both directly related to English Comprehension Fluency.

Another model was built with both word reading and morpho-syntactic skills as mediators. Paths were added from decoding, RAN, orthographic discrimination and vocabulary to syntactic awareness, morphological segmentation, and word chain. Then based on the previous model (See Figure 6.20), paths were added from decoding, vocabulary, and morphological segmentation to word reading. Finally, paths were added from all exogenous variables and mediators to comprehension fluency. Based on modification indices a path was added from syntactic awareness to morphological segmentation. The initial model provided a good fit: $\chi 2$ (6) = 7.837, p=.250, CFI=.994, RMSEA=.066, PCLOSE=.354. After deleting all insignificant paths, the final model provided a good fit as well: $\chi 2$ (19) = 18.712, p=.475, CFI=1.000, RMSEA=.000, PCLOSE=.665 (See Figure: 6.21). Like the previous model, this model shows that word chain and RAN are directly related to comprehension fluency. However, this model shows that word reading is indirectly related to comprehension fluency via word chain. It also shows that vocabulary, morpho-syntactic skills, and decoding are also indirectly related to English comprehension fluency via word reading.

Table 6.23 Regression analysis to investigate Time 3 predictors of English Comprehension Fluency

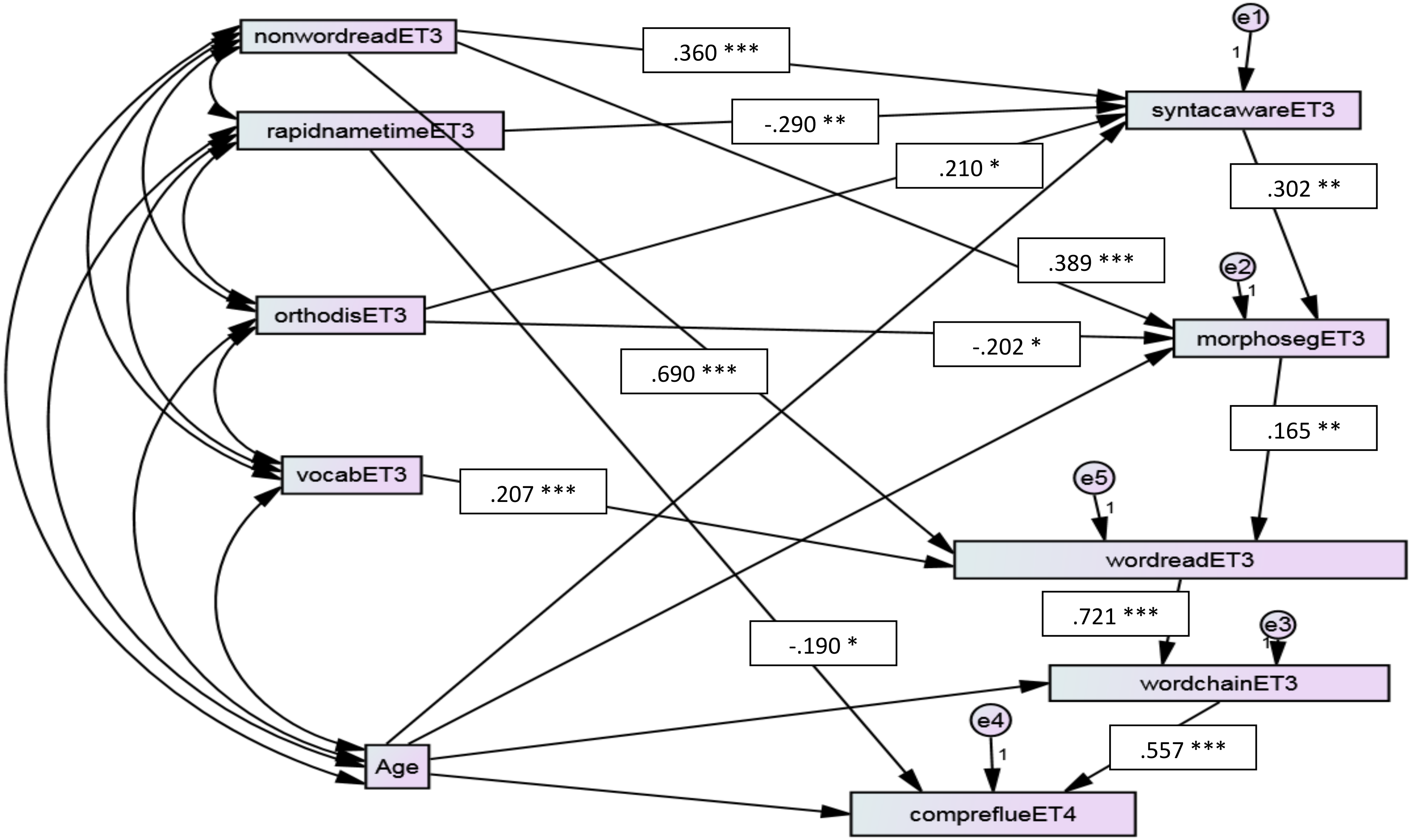
		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.212	.207	F(1,68)= 17.850 p=.000	non-word reading	-.028-
	2	word reading	.293	.081	F(1,67)= 7.637 p=.007	.099	
II	1	word reading	.292	.287	F(1,68)= 27.623 p=.000		
	2	decoding	.293	.000	F(1,67)= .009 p=.926		
III	3	vocabulary	.294	.001	F(1,66)=.118 p=.732	.029	
	4	Morpho-syntactic awareness	.309	.016	F(2,64)=.727 p=.487	syntactic awareness	-.175-
						morphological segmentation	.150
IV	3	Morpho-syntactic awareness	.307	.014	F(2,65)= .672 p=.514		
	4	vocabulary	.309	.003	F(1,64)=.244 p=.623		
V	3	phonological awareness	.319	.010	F(1,63)=.891 p=.349	rapid naming	-.170-
	4	orthographic processing	.445	.126	F(2,61)=6.913 p=.002	orthographic discrimination	.190
						word chain	.433
VI	3	orthographic processing	.427	.117	F(2,62)= 6.335 .003		
	4	phonological awareness	.445	.018	F(1,61)=2.008 p=.162		

Figure 6.20 Path diagram to show the relations between skills from Time 3 to Time 4 English comprehension fluency.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$. (Only estimates that have direct effect on Comprehension Fluency are shown)

Figure 6.21 Path diagram to show the relations between skills from Time 3 to Time 4 English comprehension fluency.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

Arabic Text Spelling

Time 1 Variables

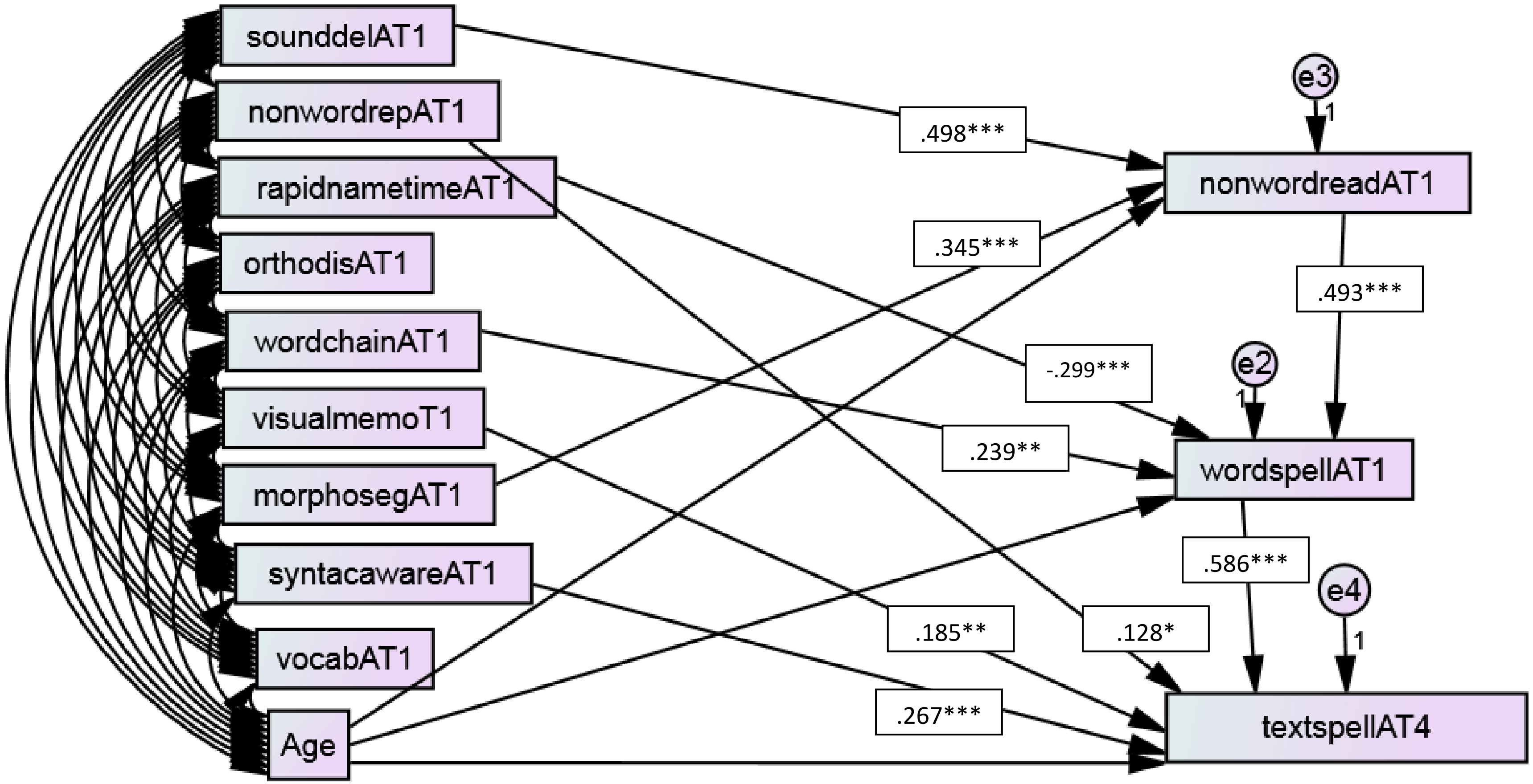
When investigating variance by measures of Time 1 on Arabic text spelling, a set of regressing analysis was conducted. For each set of these analyses, Time 4 Arabic text spelling was the dependent variable. The independent variables were Time 1 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The independent variables were entered in a set order. In each analysis, age was controlled for by being entered as step one. The results in Table 6.23 show that after controlling for age when decoding was entered before word spelling, it explained 41% of variability while word reading explained 22%. When word spelling was entered first, it explained 59% while decoding explained 4%. When controlling for age, word spelling and decoding, and then entering morpho-syntactic awareness after vocabulary, it explained 6% of variance, but when entered before it explained 7%.Vocabulary was insignificant in both cases. Both phonological awareness and orthographic processing were insignificant. From this set of analyses, it could be concluded then that the main Time 1 predictors of Arabic text spelling are word spelling, decoding, and morpho-syntactic awareness.

Path Analyses

Based on results from Chapter 5 (see Model 5.5), the first model paths from Time 1 sound deletion and morphological segmentation to Time 1 decoding; then from Time 1 decoding, RAN and word chain to Time 1 word spelling. We finally added paths from all Time 1 exogenous variables, in addition to Time 1 word spelling and decoding to Time 4 Text Spelling. We allowed the Time 1 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (14) = 18.071, p=.204, CFI=.987, RMSEA=.064, PCLOSE=.353. To build a simplified model, we used variables with significant paths only, (See Figure 6.22). The final model was a good fit to the data set: $\chi 2$ (21) = 24.983, p=.248, CFI=.987, RMSEA=.052 PCLOSE=.444. The model shows that Time 1 Arabic text spelling predictors are word spelling, non-word repetition, syntactic awareness and visual memory. It also shows that RAN, word chain, and decoding are indirectly related to Arabic text spelling via word spelling.

Table 6.24 Regression analysis to investigate Time 1 predictors of Arabic Text Spelling							
		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.409	.409	F(1,68)= 47.078 p=.000	non-word reading	.117
	2	word spelling	.628	.219	F(1,67)= 39.388 p=.000	.411	
II	1	word spelling	.590	.590	F(1,68)= 97.881 p=.000		
	2	decoding	.628	.038	F(1,67)= 6.806 p=.011		
III	3	vocabulary	.640	.012	F(1,66)= 2.247 p=.139	.004	
	4	Morpho-syntactic awareness	.696	.055	F(2,64)= 5.828 p=.005	syntactic awareness	.212
						morphological segmentation	-.013-
IV	3	Morpho-syntactic awareness	.695	.067	F(2,65)= 7.199 p=.001		
	4	vocabulary	.696	.046	F(1,64)=.046 p=.832		
V	3	phonological awareness	.726	.031	F(3,61)= 2.292 p=.087	sound deletion	.082
						rapid naming	-.051-
						non-word repetition	.134
	4	orthographic processing	.751	.025	F(3,58)= 1.909 p=.138	orthographic discrimination	-.006-
						word chain	.099
						visual memory	.160
VI	3	orthographic processing	.729	.033	F(3,61)= 2.466 p=.071		
	4	phonological awareness	.751	.022	F(3,58)= 1.747 p=.167		

Figure 6.22 Path diagram to show the relations between skills from Time 1 variables to Time 4 Arabic text spelling.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$.

Time 2 Variables

The variance by measures of Time 2 on Arabic Text Spelling was tested with a set of regressing analysis. For each set of these analyses, Time 4 Arabic Text Spelling was the dependent variable. The independent variables were Time2 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.24 shows that after controlling for age when decoding was entered before word spelling it explained 58 % of variability while word spelling explained 11%. When word spelling was entered first, it explained 61% while decoding became insignificant. Both vocabulary and orthographic processing were insignificant. These results show that the main Time 2 predictors of Arabic Text Spelling are word spelling and decoding.

Path Analyses

When trying to build a model, with both word spelling and decoding as mediators, the model did not provide quite a good fit to the data set even after deleting insignificant paths: $\chi 2$ (3) = 8.286, p=.040, CFI=.968, RMSEA=.159, PCLOSE=.069. When trying to build a model with word spelling only as a mediator, the model that resulted provided the same previous fit. Both models showed that word spelling and decoding were the only variables directly related to Text Spelling.

Table 6.25 Regression analysis to investigate Time 2 predictors of Arabic Text Spelling

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.582	.582	F(1,68)= 94.771 p=.000	non-word reading	.361
	2	word spelling	.691	.109	F(1,67)= 23.556 p=.000	.412	
II	1	word spelling	.614	.614	F(1,68)= 107.974 p=.000		
	2	decoding	.691	.077	F(1,67)= 16.762 p=.000		
III	3	vocabulary	.699	.008	F(1,66)= 1.699 p=.197	.104	
	4	orthographic processing	.712	.013	F(1,65)= 2.984 p=.089	word chain	.133
IV	3	orthographic processing	.704	.013	F(1,66)= 2.802 p=.099		
	4	vocabulary	.712	.008	F(1,65)=1.895 p=.173		

Time 3 Variables

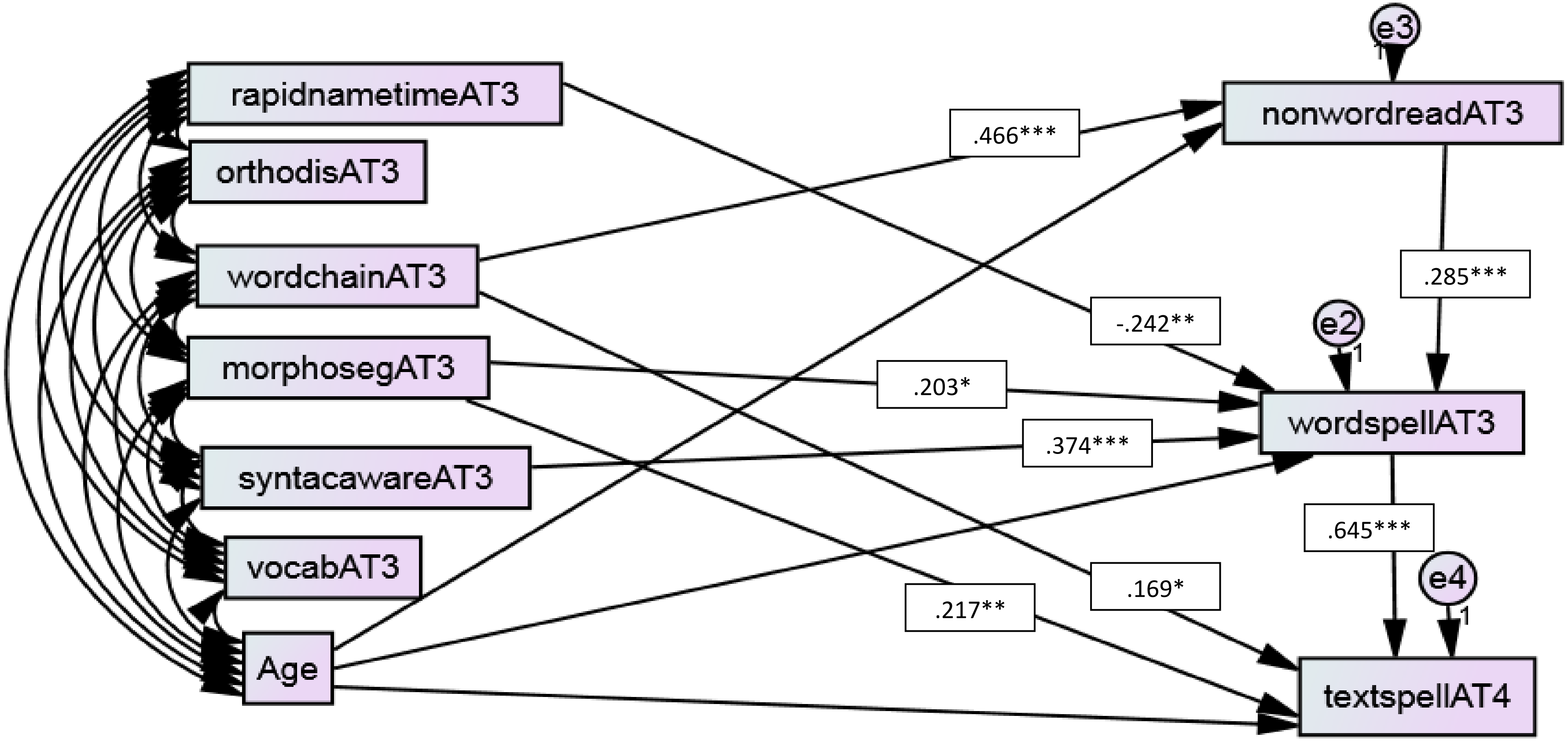
Finally, the variance made by measures of Time 3 on Arabic Text Spelling was tested with a set of regressing analysis. For each set of these analyses, Time 4 Arabic Text Spelling was the dependent variable. The independent variables were Time 3 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.25 shows that when decoding was entered before word spelling, it explained 27% of variability while word spelling explained 41%. When word spelling was entered first, it explained 66% while decoding explained only 2%. When vocabulary was entered before morpho-syntactic skills, the latter explained 5% of variance. When morpho-syntactic skill was entered first, it explained 6%. Vocabulary was insignificant in both cases. Both phonological processing and orthographic processing were insignificant. It could be concluded then that the main Time 3 predictors of Arabic text spelling are word spelling, decoding, and morpho-syntactic awareness.

Path Analyses

Based on results in Chapter 5 (see Model 5.13); the initial model included paths from Time 3 word chain to Time 3 decoding, and from Time 3 decoding, RAN, morphological segmentation and syntactic awareness to Time 3 word spelling. Then added paths from all Time exogenous variables, in addition to Time 3 decoding and word spelling to Time 4 text spelling. We allowed the Time 3 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (8) = 9.464, p=.305, CFI=.994, RMSEA=.051, PCLOSE=.430. To build a simplified model, we used significant paths only. The model provided a good fit to the data set: $\chi 2$ (13) = 15.351, p=.186, CFI=.991, RMSEA=.051, PCLOSE=.444 (See figure 6.23) The path analysis shows that the main Time 3 predictors of Arabic Text Spelling are word spelling, word chain, and morphological segmentation. Decoding, syntactic awareness, morphological segmentation and rapid naming are all indirectly related to Arabic text spelling via word spelling.

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
Table 6.26 Regression analysis to investigate Time 3 predictors of Arabic Text Spelling							
I	1	decoding	.268	.268	F(1,68)= 24.856 p=.000	non-word reading	.079
	2	word spelling	.680	.413	F(1,67)= 86.546 p=.000	.563	
II	1	word spelling	.662	.662	F(1,68)= 133.020 p=.000		
	2	decoding	.680	.019	F(1,67)= 3.927 p=.052		
III	3	vocabulary	.696	.016	F(1,66)= 3.428 p=.069	.086	
	4	Morpho-syntactic awareness	.745	.049	F(2,64)= 6.102 p=.004	syntactic awareness	.131
						morphological segmentation	.159
IV	3	Morpho-syntactic awareness	.742	.061	F(2,65)= 7.727 p=.001		
	4	vocabulary	.745	.003	F(1,64)=.763 p=.386		
V	3	phonological awareness	.746	.001	F(1,63)= .338 p=.563	rapid naming	.059
	4	orthographic processing	.763	.017	F(2,61)= 2.158 p=.124	orthographic discrimination	.018
						word chain	.162
VI	3	orthographic processing	.761	.016	F(2,62)= 2.093 p=.132		
	4	phonological awareness	.763	.002	F(1,61)=.513 p=.476		

Figure 6.23 Path diagram to show the relations between skills from Time 3 variables to Time 4 Arabic Text Spelling.



Note. Numbers in the figure are standardised regression weights. ∗*p*=.05. ∗∗*p*=.01.∗∗∗*p* < .001.

English Text Spelling

Time 1 Variables

When investigating variance by measures of Time 1 on English Text Spelling, a set of regressing analysis was conducted. For each set of these analyses, Time 4 English Text Spelling was the dependent variable. The independent variables were Time 1 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The data in Table 6.26 show that after controlling for age when decoding was entered before word spelling, it explained 56% of variability while word spelling explained 4%. When word spelling was entered first, it explained 29% while decoding explained 31%. After controlling for age, decoding and word spelling, then vocabulary was entered before morpho-syntactic awareness it explained 6% of variance, but when entered after it was insignificant. When morpho-syntactic awareness was entered before vocabulary it explained 12% of variance, and when entered after it explained 6%. Both phonological awareness and orthographic processing were insignificant. From this set of analyses, it could be concluded then that the main Time 1 predictors of English text spelling are word spelling, decoding, and morpho-syntactic awareness. To investigate these relationships, a path analysis was conducted.

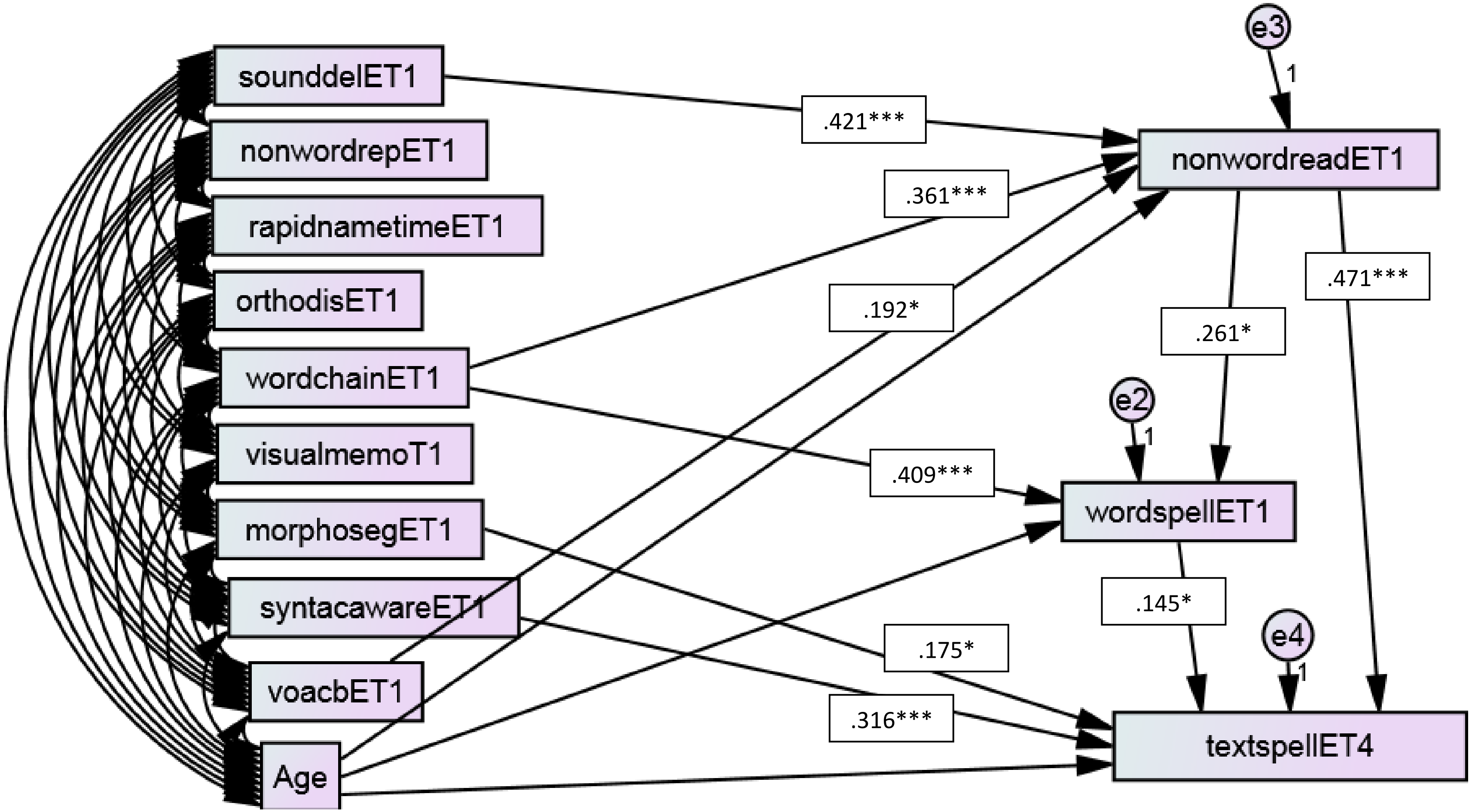
Path Analyses

Based on results from Chapter 5 (see Model 5.6); the first model included paths from Time 1 variables to Time 1 word spelling, and from all Time 1 sound deletion, word chain and vocabulary to Time 1 decoding and from Time 1 decoding and word chain to Time 1 word spelling. Finally, we added paths from all exogenous variables in addition to Time decoding and word reading to Time 4 text spelling. We allowed the Time 1 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (14) = 11.045, p=.682, CFI=1.000, RMSEA=.000, PCLOSE=.808. To build a simplified model, we used variables with significant paths only (See Figure 6.24). The final model was a good fit to the data set: $\chi 2$ (21) = 20.249 p=.506, CFI=1.000, RMSEA=.000 PCLOSE=.700. The model shows that Time 1 English text spelling predictors are word spelling, morphological segmentation, syntactic awareness, and decoding. It also shows that word chain is indirectly related to text spelling via word spelling. In addition, both vocabulary and sound deletion have paths to decoding which indirectly affects Text Spelling via word spelling.

Table 6.27 Regression analysis to investigate Time 1 predictors of English Text Spelling

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.562	.561	F(1,68)= 87.152 p=.000	non-word reading	.427
	2	word spelling	.600	.038	F(1,67)= 6.286 p=.015	.148	
II	1	word spelling	.289	.289	F(1,68)= 27.601 p=.000		
	2	decoding	.600	.310	F(1,67)= 51.937 p=.000		
III	3	vocabulary	.662	.062	F(1,66)= 12.131 p=.001	.091	
	4	Morpho-syntactic awareness	.726	.064	F(2,64)= 7.472 p=.001	syntactic awareness	.175
						morphological segmentation	.193
IV	3	Morpho-syntactic awareness	.717	.117	F(2,65)= 13.442 p=.000		
	4	vocabulary	.726	.009	F(1,64)= 2.111 p=.151		
V	3	phonological awareness	.749	.023	F(3,61)= 1.887 p=.141	sound deletion	-.049-
						rapid naming	-.112-
						non-word repetition	.094
	4	orthographic processing	.752	.003	F(3,58)=.200 p=.896	orthographic discrimination	-.043-
						word chain	.045
						visual memory	.023
VI	3	orthographic processing	.731	.005	F(3,61)=.385 p=.764		
	4	phonological awareness	.752	.021	F(3,58)=1.616 p=.195		

Figure 6.24 Path diagram to show the relations between skills from Time 1 variables to Time 4 English text spelling



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$.

Time 2 Variables

The variance by measures of Time 2 on English Text Spelling was tested with a set of regressing analysis. For each set of these analyses, Time 4 English Text Spelling was the dependent variable. The independent variables were Time2 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.27 shows that after controlling for age when decoding was entered before word spelling, it explained 73 % of variability while word spelling explained 9%. When word spelling was entered first, it explained 69% while decoding explained 13%. Both vocabulary and orthographic processing were insignificant. These results show that the main Time 2 predictors of English Text Spelling are decoding and word spelling.

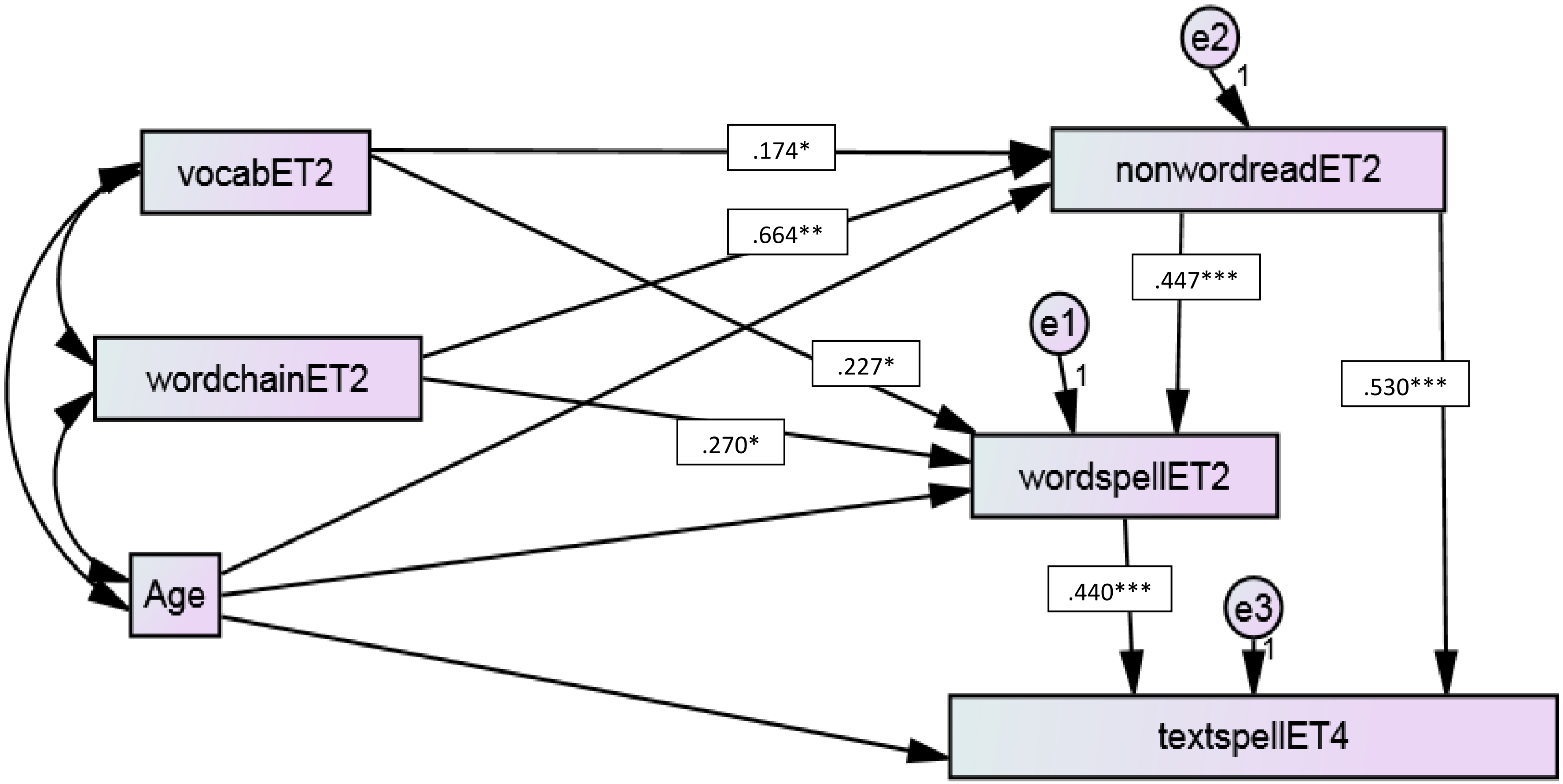
Path Analyses

Based on results from Chapter 5; the first model paths from Time 2 variables to Time 2 vocabulary and word chain to Time 2 decoding, then from Time 2 decoding, vocabulary and word chain to Time 2 word spelling. We then added paths from all Time 2 exogenous variables, in addition to decoding and word spelling to Time 4 text spelling. We allowed the Time 2 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model was saturated, so it was not a good fit to the data set. We, therefore, based on the regression results from Table 6.24, deleted paths from both vocabulary and chain to text spelling (which were both insignificant in the initial path model). The model was a good fit to the data set: $\chi 2$ (2) = 2.925, p=.232, CFI=.996, RMSEA=.081, PCLOSE=.290 (see Model 6.28). The path analysis shows that the main Time 2 predictors of English text spelling are word spelling and decoding. It also indicates that decoding, word chain, and vocabulary are indirectly related to English text spelling via word spelling.

Table 6.28 Regression analysis to investigate Time 2 predictors of English Text Spelling

		Variables	R^2	R^2 chang	Sig R^2 change	Final Beta	
I	1	decoding	.730	.730	F(1,68)= 183.878 p=.000	non-word reading	.562
	2	word spelling	.819	.088	F(1,67)= 32.601 p=.000	.427	
II	1	word spelling	.690	.689	F(1,68)= 151.151 p=.000		
	2	decoding	.819	.129	F(1,67)= 47.475 p=.000		
III	3	vocabulary	.823	.005	F(1,66)=1.830 p=.181	.081	
	4	orthographic processing	.826	.003	F(2,65)=.945 p=.335	word chain	-.077-
IV	3	orthographic processing	.821	.003	F(1,66)=.955 p=.332		
	4	vocabulary	.826	.005	F(1,65)=1.807 p=.184		

Figure 6.24 Path diagram to show the relations between skills from Time 2 variables to Time 4 English Text Spelling



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

Time 3 Variables

Finally, the variance by measures of Time 3 on English Text Spelling was tested with a set of regressing analysis. For each set of these analyses, Time 4 English Text Spelling was the dependent variable. The independent variables were Time 3 decoding, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.29 shows that, after controlling for age, both decoding and word spelling added unique variance. When decoding was entered before word spelling, it explained 64% of variability while word spelling explained 14%. When word spelling was entered first, it explained 65% while decoding explained 13%. After controlling for age, decoding and word spelling, when vocabulary was entered before morpho-syntactic skills, it explained 2% of variance, and morpho-syntactic skills explained 2%. When morpho-syntactic skill was entered first, it explained 3% and vocabulary 2%. Both phonological processing and orthographic processing were insignificant. It could be concluded then that the main Time 3 predictors of English text spelling are word spelling, decoding, vocabulary and morpho-syntactic awareness.

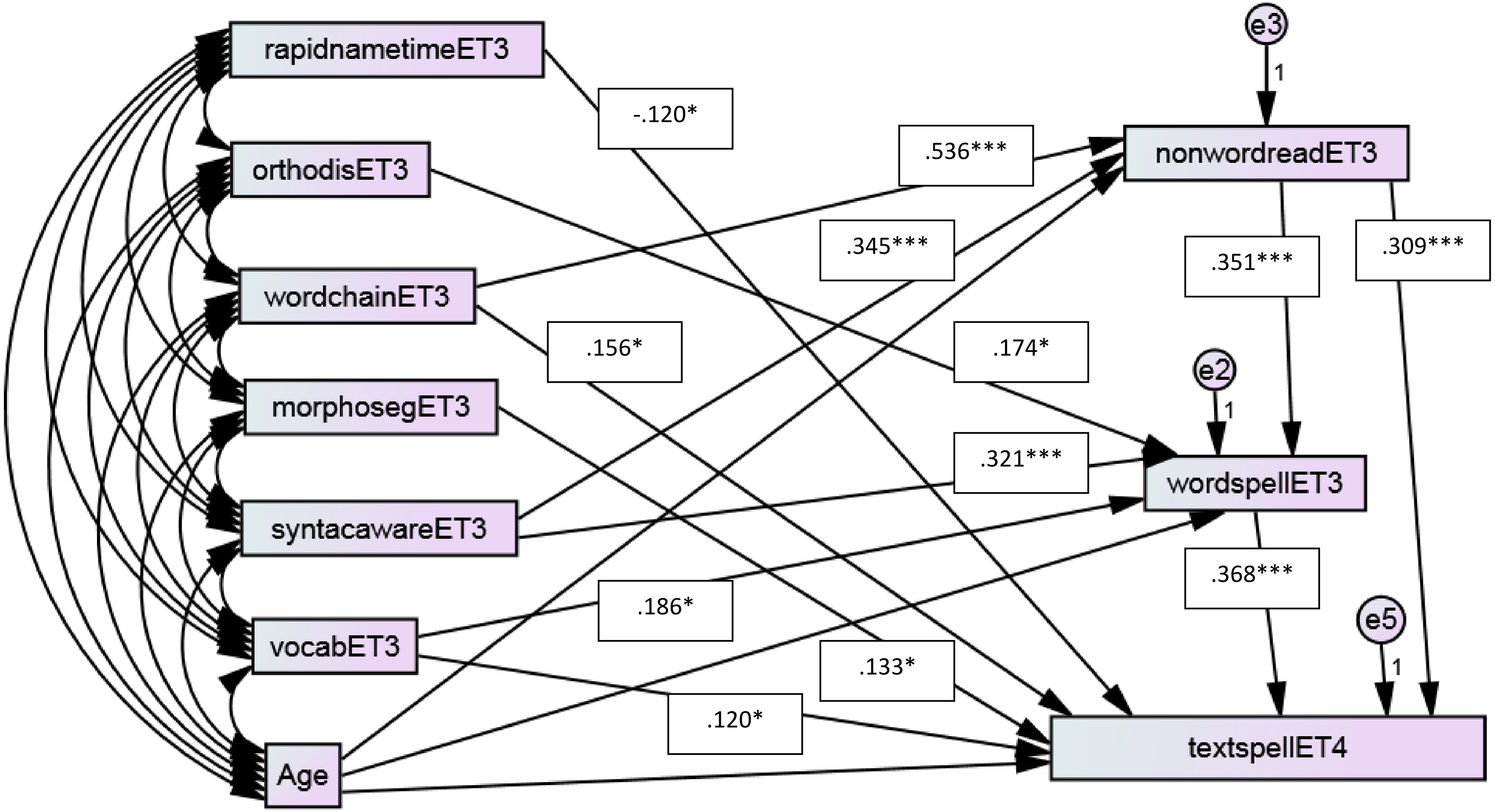
Path Analyses

Based on results from Chapter 5 (see Model 5.14); the first model included paths from Time 3 word chain and syntactic awareness to Tim 3 decoding, and from Time 3 decoding, orthographic discrimination, syntactic awareness and vocabulary to Time 3 word spelling. Finally, we added paths from all Time 3 exogenous variables, in addition to Time 3 decoding and word spelling to Time 4 text spelling. We allowed the Time 3 (exogenous) variables to covary. Age was controlled for as previously discussed. The model was a good fit: $\chi 2$ (7) = 7.316, p=.397, CFI=.999, RMSEA=.025, PCLOSE=.516. To build a simplified model, we used paths with significant values only. The final model provided a good fit: $\chi 2$ (9) = 7.991, p=.535, CFI=1.000, RMSEA=.000, PCLOSE=.661 (see Model 6.25). The path analysis shows that the main Time 3 predictors of English Text Spelling are word spelling, decoding, rapid naming, word chain and morphological segmentation, and vocabulary. It also indicates that decoding, syntactic awareness, vocabulary and orthographic discrimination are all indirectly related to English text spelling via word spelling.

Table 6.29 Regression analysis to investigate Time 3 predictors of English Text Spelling

<table>
<tr><th></th><th></th><th>Variables</th><th>R²</th><th>R² change</th><th>Sig R² change</th><th colspan="2">Final Beta</th></tr>
<tr><td rowspan="2">I</td><td>1</td><td>decoding</td><td>.637</td><td>.637</td><td>F(1,68)= 119.307
p=.000</td><td>non-word reading</td><td>.296</td></tr>
<tr><td>2</td><td>word spelling</td><td>.781</td><td>.144</td><td>F(1,67)= 43.917
p=.000</td><td colspan="2">.334</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>word spelling</td><td>.651</td><td>.650</td><td colspan="3">F(1,68)= 126.520
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.781</td><td>.130</td><td colspan="3">F(1,67)= 39.804
p=.000</td></tr>
<tr><td rowspan="3">III</td><td>3</td><td>vocabulary</td><td>.801</td><td>.020</td><td>F(1,66)= 6.743
p=.012</td><td colspan="2">.114</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.822</td><td rowspan="2">.020</td><td rowspan="2">F(2,64)= 3.676
p=.031</td><td>syntactic awareness</td><td>.045</td></tr>
<tr><td>morphological segmentation</td><td>.127</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>Morpho-syntactic awareness</td><td>.807</td><td>.026</td><td colspan="3">F(2,65)=4.356
p=.017</td></tr>
<tr><td>4</td><td>vocabulary</td><td>.822</td><td>.015</td><td colspan="3">F(1,64)=5.347
p=.024</td></tr>
<tr><td rowspan="3">V</td><td>3</td><td>phonological awareness</td><td>.827</td><td>.006</td><td>F(1,63)= 2.082
p=.154</td><td>rapid naming</td><td>-.108-</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">orthographic processing</td><td rowspan="2">.840</td><td rowspan="2">.013</td><td rowspan="2">F(2,61)= 2.456
p=.094</td><td>orthographic discrimination</td><td>.021</td></tr>
<tr><td>word chain</td><td>.154</td></tr>
<tr><td rowspan="2">VI</td><td>3</td><td>orthographic processing</td><td>.833</td><td>.011</td><td colspan="3">F(2,62)=2.053
p=.137</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.840</td><td>.007</td><td colspan="3">F(1,61)=2.862
p=.096</td></tr>
</table>

Figure 6.25 Path diagram to show the relations between skills from Time 3 variables to Time 4 English Text Spelling



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

Arabic Composition Coherence

Time 1 Variables

When investigating variance by measures of Time 1 on Arabic Composition Coherence, a set of regressing analysis was conducted. For each set of these analyses, Time 4 Arabic Composition Coherence was the dependent variable. The independent variables were Time 1 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The results in Table 6.30 show that after controlling for age when decoding was entered before word spelling, it explained 20% of variability while word spelling explained 5%. When word spelling was entered first, it explained 21% while decoding became insignificant. When controlling for age, decoding and word spelling, then vocabulary was entered before morpho-syntactic awareness, the latter explained 7% of variance, but when entered after it, morpho-syntactic awareness explained 10%. Vocabulary was insignificant in both cases. Both phonological awareness and orthographic processing were insignificant. From this set of analyses, it could be concluded then that the main Time 1 predictors of Arabic composition coherence are word spelling and morpho-syntactic processing. To investigate these relationships, a path analysis was conducted.

Path Analyses

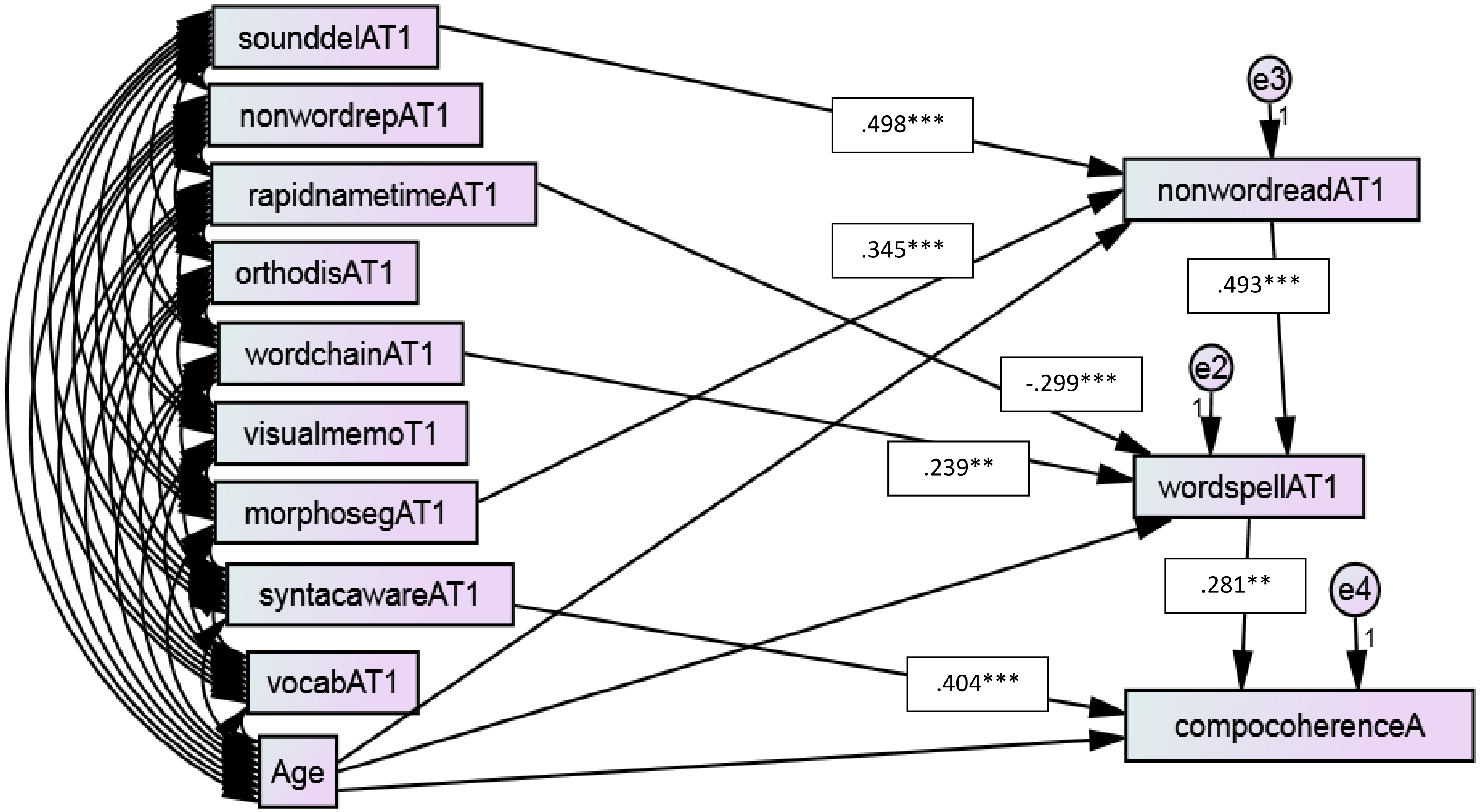
Based on results from Word Spelling Model in Chapter 5 (see Model 5.5), we had paths from Time 1 morphological segmentation and sound deletion to Time 1 Decoding (which was used as a mediator), then from Time 1 Decoding, RAN, and word chain to Time 1 word spelling (which was also used as a mediator). We then added all possible paths from exogenous variables, in addition to decoding and word spelling, to Composition Coherence. We controlled for age as discussed before. We allowed the Time 1 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (14) = 18.071, p=.204, CFI=.983, RMSEA=.064, PCLOSE=.353. To build a simpler model, we used variables with significant paths only (See Figure 6.26). The final model provided a good fit to the data set: $\chi 2$ (23) = 25.422, p=.329, CFI=.990, RMSEA=.039, PCLOSE=.544. The model shows that Time 1 word spelling and syntactic awareness are directly related to composition coherence. The findings also indicate that Time 1 decoding, RAN, and word chain are indirectly related to composition coherence via word spelling (Note that vocabulary path to word spelling was significant at level .1).

Another model was built using both word spelling and morpho-syntactic skills as mediators. The initial hypothesised model included paths from Time 1 Decoding, RAN, word chain and both morphological and syntactic awareness (in addition to vocabulary) to Time 1 word spelling. Then we added paths from all exogenous variables, in addition to word spelling to both syntactic awareness and morphological segmentation. We also had a path from syntactic awareness to morphological segmentation. Finally, we had paths from all exogenous variables in addition to word spelling, syntactic awareness and morphological segmentation to composition coherence. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (2) = 2.779, p=.249, CFI=.997, RMSEA=.075, PCLOSE=.308. To build a simpler model, we used variables with significant paths only (See Figure 8.27). The final model provided a good fit to the data set: $\chi 2$ (25) = 26.129, p=.401, CFI=.995, RMSEA=.025, PCLOSE=.625.

Like the previous model, this model shows that word spelling, syntactic awareness are directly related to composition coherence. However, this model shows that vocabulary is indirectly related to coherence via syntactic awareness and it that morphological segmentation is indirectly related to coherence via word spelling.

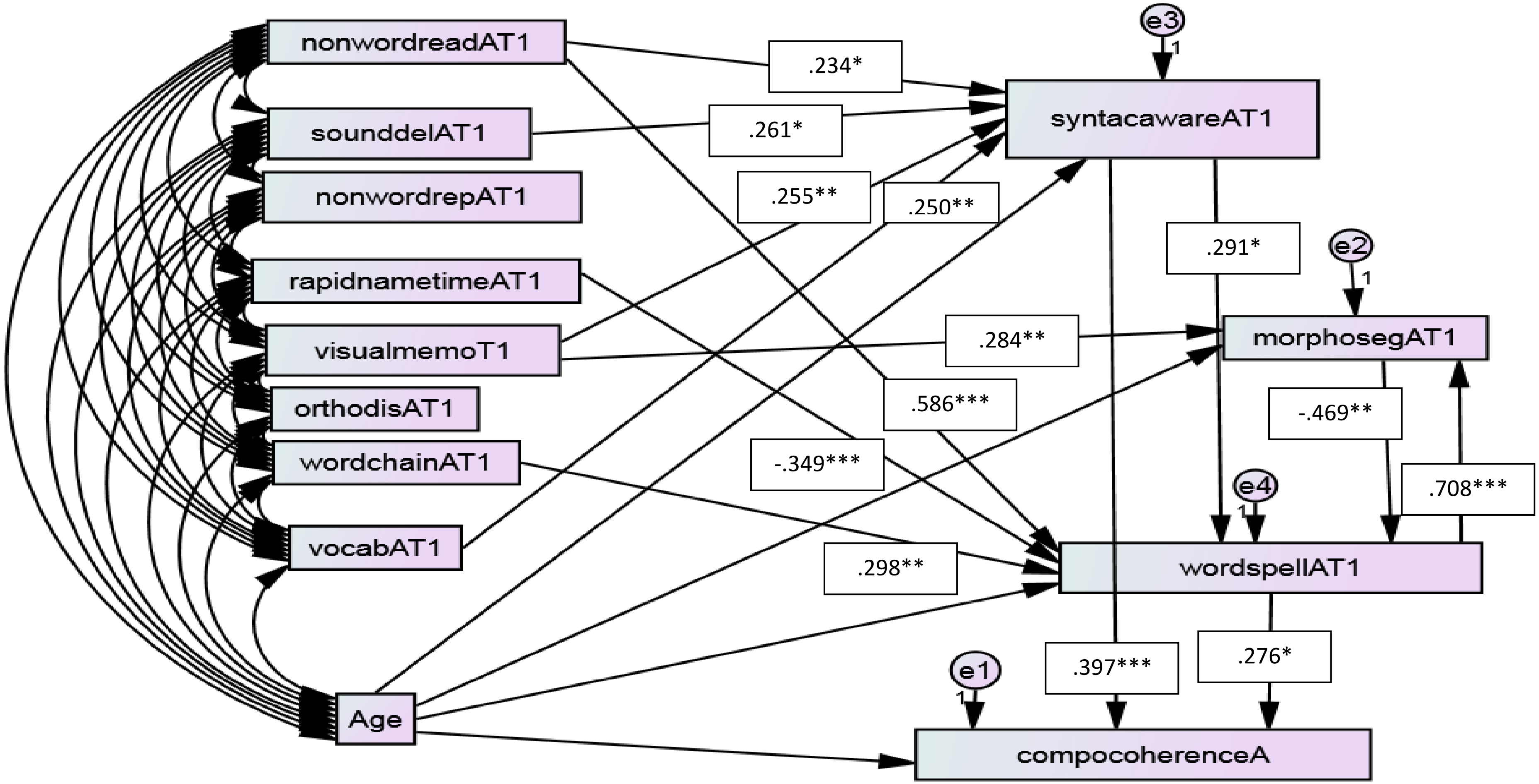
<table>
<tr><th colspan="8">Table 6.30 Regression analysis to investigate Time 1 predictors of Arabic Composition Coherence</th></tr>
<tr><th colspan="2"></th><th>Variables</th><th>R^2</th><th>R^2 change</th><th>Sig R^2 change</th><th colspan="2">Final Beta</th></tr>
<tr><td rowspan="2">I</td><td>1</td><td>decoding</td><td>.202</td><td>.196</td><td>F(1,68)= 16.702
p=.000</td><td>non-word reading</td><td>.130</td></tr>
<tr><td>2</td><td>word spelling</td><td>.256</td><td>.054</td><td>F(1,67)=4.908
p=.030</td><td colspan="2">.201</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>word spelling</td><td>.219</td><td>.214</td><td colspan="3">F(1,68)=18.603
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.256</td><td>.037</td><td colspan="3">F(1,67)=3.329
p=.073</td></tr>
<tr><td rowspan="3">III</td><td>3</td><td>vocabulary</td><td>.283</td><td>.027</td><td>F(1,66)=2.445
p=.123</td><td colspan="2">.044</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.357</td><td rowspan="2">.074</td><td rowspan="2">F(2,64)=3.677
p=.031</td><td>syntactic awareness</td><td>.284</td></tr>
<tr><td>morphological segmentation</td><td>.074</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>Morpho-syntactic awareness</td><td>.355</td><td>.098</td><td colspan="3">F(2,65)=4.941
p=.010</td></tr>
<tr><td>4</td><td>vocabulary</td><td>.357</td><td>.232</td><td colspan="3">F(1,64)=.232
p=.632</td></tr>
<tr><td rowspan="6">V</td><td rowspan="3">3</td><td rowspan="3">phonological awareness</td><td rowspan="3">.380</td><td rowspan="3">.024</td><td rowspan="3">F(3,61)=.773</td><td>sound deletion</td><td>-.094-</td></tr>
<tr><td>rapid naming</td><td>.087</td></tr>
<tr><td>non-word repetition</td><td>.137</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">orthographic processing</td><td rowspan="3">.400</td><td rowspan="3">.020</td><td rowspan="3">F(3,58)=.642
p=.591</td><td>orthographic discrimination</td><td>.023</td></tr>
<tr><td>word chain</td><td>.169</td></tr>
<tr><td>visual memory</td><td>.011</td></tr>
<tr><td rowspan="2">VI</td><td>3</td><td>orthographic processing</td><td>.378</td><td>.021</td><td colspan="3">F(3,61)=.699
p=.557</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.400</td><td>.022</td><td colspan="3">F(3,58)=.713
p=.548</td></tr>
</table>

Figure 6.26 Path diagram to show the relations between skills from Time 1 variables to Time 4 Arabic composition coherence.



Note. Numbers in the figure are standardised regression weights. $*p=.05$. $**p=.01$. $***p < .001$.

Figure 6.27 Path diagram to show the relations between skills from Time 1 variables to Time 4 Arabic composition coherence.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

Time 2 Variables

The variance by measures of Time 2 on Arabic composition coherence was tested with a set of regressing analysis. For each set of these analyses, Time 4 Arabic composition coherence was the dependent variable. The independent variables were Time2 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.31 shows that, after controlling for age, when decoding was entered before word spelling it explained 14 % of variability while word spelling explained 15%. When word spelling was entered first, it explained 29% while decoding became insignificant. Both vocabulary and orthographic processing were insignificant. These results show that the main Time 2 predictor of Arabic composition coherence is word spelling.

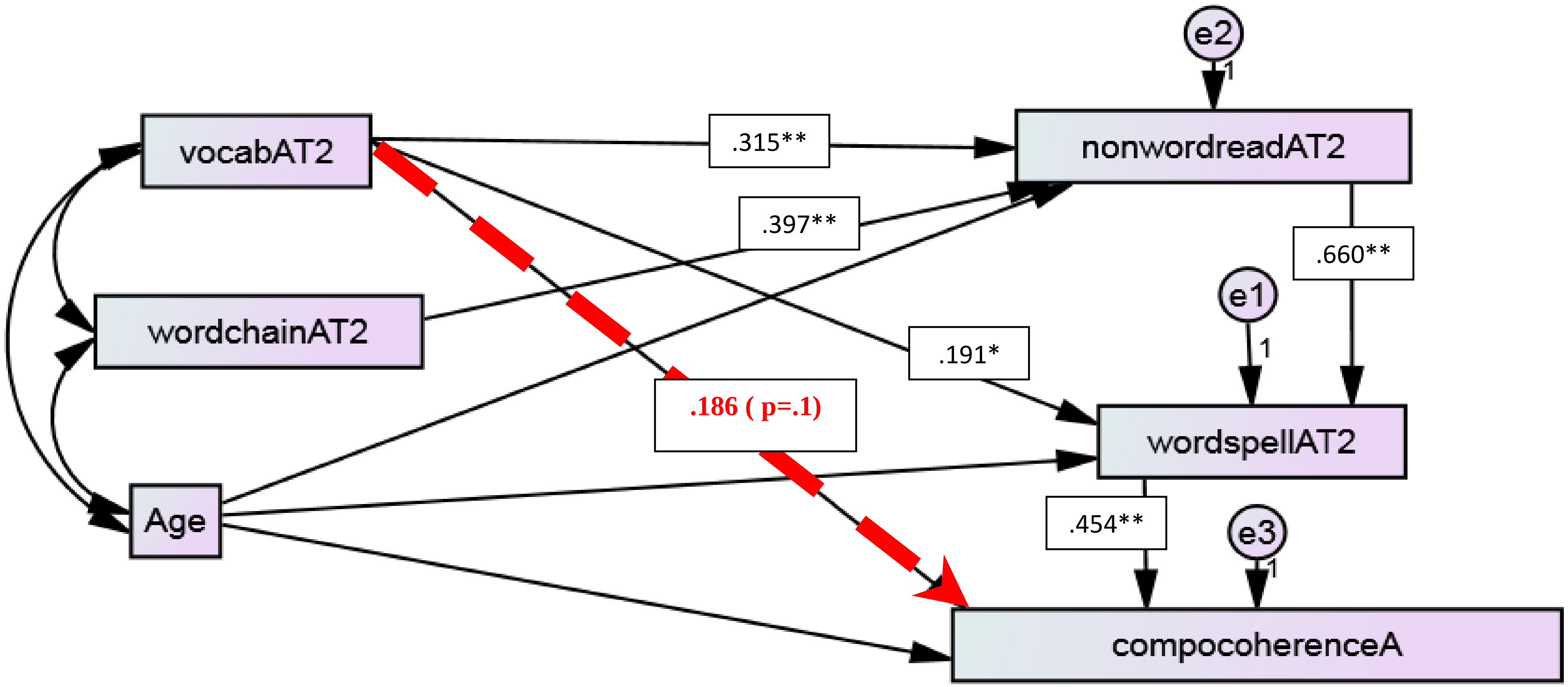
Path Analyses

Based on regression results (see Chapter 5)the first model included paths from Time 2 vocabulary and word chain to Time decoding, and from Time 2 vocabulary, word chain and decoding to Time 2 word spelling. Finally, we added paths from Time 2 vocabulary, word chain, decoding and word spelling to Time 4 composition coherence. We allowed the Time 2 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model did not provide a good fit to the data set, since it was saturated and probability could not be completed. Therefore, we used significant paths only, but the model did not provide a good fit to the data set: $\chi 2$ (4) = 6.611, p=.158, CFI=.975, RMSEA=.097, PCLOSE=.229. However, when adding a path from vocabulary to coherence (which was significant at level .1), the model fit improved: $\chi 2$ (3) = 3.863, p=.277, CFI=.922, RMSEA=.064, PCLOSE=.351 (See figure 6.28).The model shows that both word spelling and vocabulary are directly related to Arabic composition coherence. It also indicates that decoding and vocabulary are indirectly related to Arabic composition coherence via word spelling.

Table 6.31 Regression analysis to investigate Time 2 predictors of Arabic Composition Coherence

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	decoding	.147	.141	F(1,68)= 11.264 p=.001	non-word reading	-.049-
	2	word spelling	.295	.148	F(1,67)= 14.028 p=.000	.518	
II	1	word spelling	.294	.288	F(1,68)=27.771 p=.000		
	2	decoding	.295	.001	F(1,67)=.062 p=.804		
III	3	vocabulary	.323	.028	F(1,66)= 2.772 p=.101	.190	
	4	orthographic processing	.326	.003	F(1,65)= .280 p=.598	word chain	-.062-
IV	3	orthographic processing	.298	.004	F(1,66)=.329 p=.568		
	4	vocabulary	.326	.028	F(1,65)=2.685 p=.106		

Figure 6.28 Path diagram to show the relations between skills from Time 2 variables to Time 4 Arabic composition coherence



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001.

Time 3 Variables

Finally, the variance made by measures of Time 3 on each of Arabic composition coherence was tested with a set of regressing analysis. For each set of these analyses, Time 4 Arabic composition coherence was the dependent variable. The independent variables were Time 3 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.32 shows that after controlling for age, when decoding was entered before word spelling, it explained 6% of variability while word spelling explained 28%. When word spelling was entered first, it explained 33% while decoding became insignificant. Morpho-syntactic skills, vocabulary, phonological processing and orthographic processing were insignificant. It could be concluded then that the main Time 3 predictor of Arabic composition coherence is word spelling.

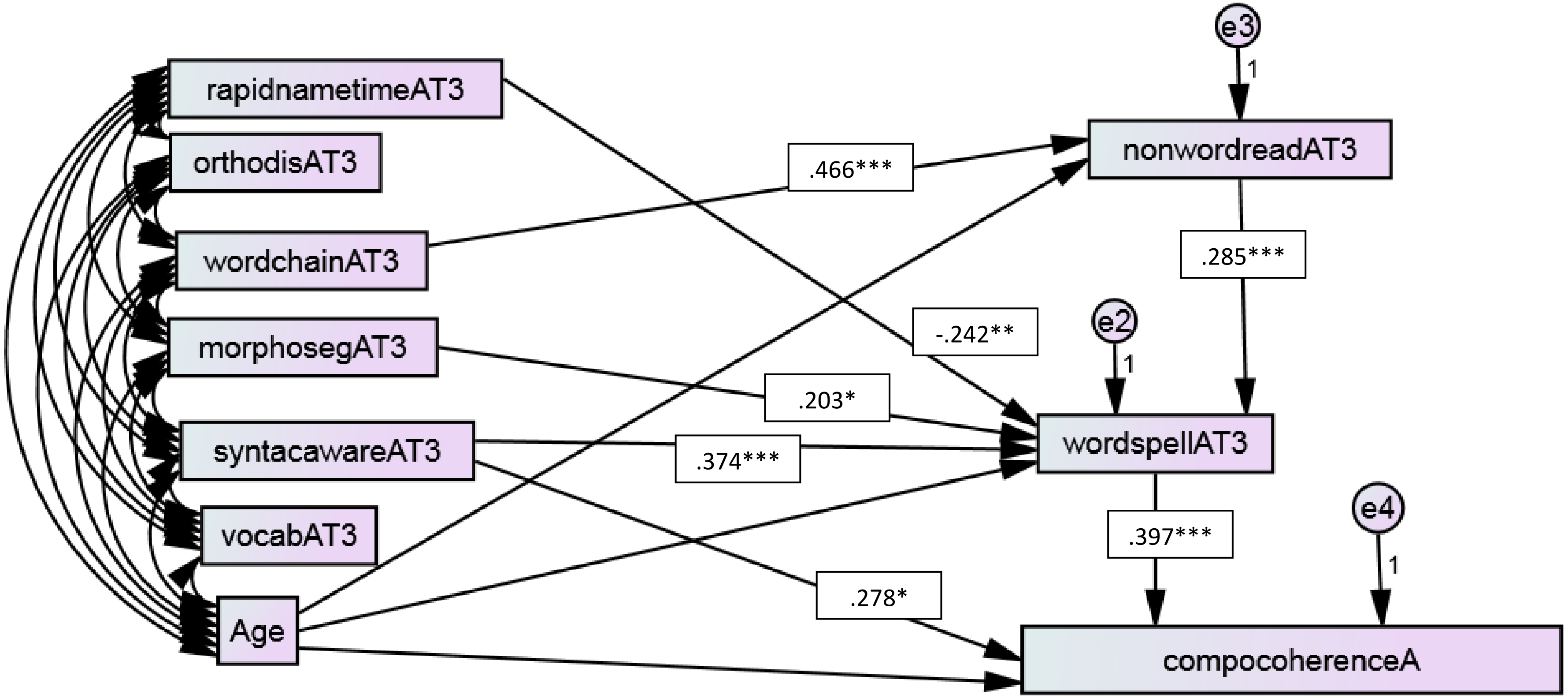
Path Analyses

Based on results from Chapter 5 (see Model 5.13); the first model included paths from Time 3 word chain to Time 3 decoding, and from Time 3 decoding, RAN, morphological segmentation and syntactic awareness to Time 3 word spelling. Then we added paths from all Time 3 exogenous variables in addition to decoding and word reading to Time 4 composition coherence. We allowed the Time 3 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (8) = 9.464, p=.305, CFI=.992, RMSEA=.051, PCLOSE=.430. To build a simplified model, we used significant paths only. The final model provided a good fit to the data set: $\chi 2$ (14) = 14.812, p=.391, CFI=.996, RMSEA=.029, PCLOSE=.560 (See Figure 6.29). The path shows that word spelling and syntactic awareness are directly related to coherence. It also indicates that rapid naming, decoding, morphological segmentation and syntactic awareness are indirectly related to Arabic composition coherence via word spelling.

We tried to build another model with word spelling, morphological segmentation and syntactic awareness as mediators. The initial model included paths from decoding, RAN morphological segmentation and syntactic awareness to word spelling. Then we had paths from all exogenous variables to both morphological segmentation and syntactic awareness. Finally, we added paths from all exogenous variables in addition to word spelling, morphological segmentation and syntactic awareness to composition coherence. We allowed the Time 3 (exogenous) variables to covary. Age was controlled for as previously discussed. Based on modification indices another path was added from syntactic awareness to morphological segmentation. The initial hypothesised model did not provide a good fit to the data set: $\chi 2$ (2) = 2.867, p=.238, CFI=.995, RMSEA=.079, PCLOSE=.297. To build a simplified model, we used significant paths only; the model provided a good fit to the data set: $\chi 2$ (16) = 15.482, p=.490, CFI=1.000, RMSEA=.000, PCLOSE=.663 (See Figure 6.30). The model shows that word spelling and syntactic awareness are directly related to coherence. It also indicates that vocabulary is indirectly related to Arabic composition coherence via syntactic awareness.

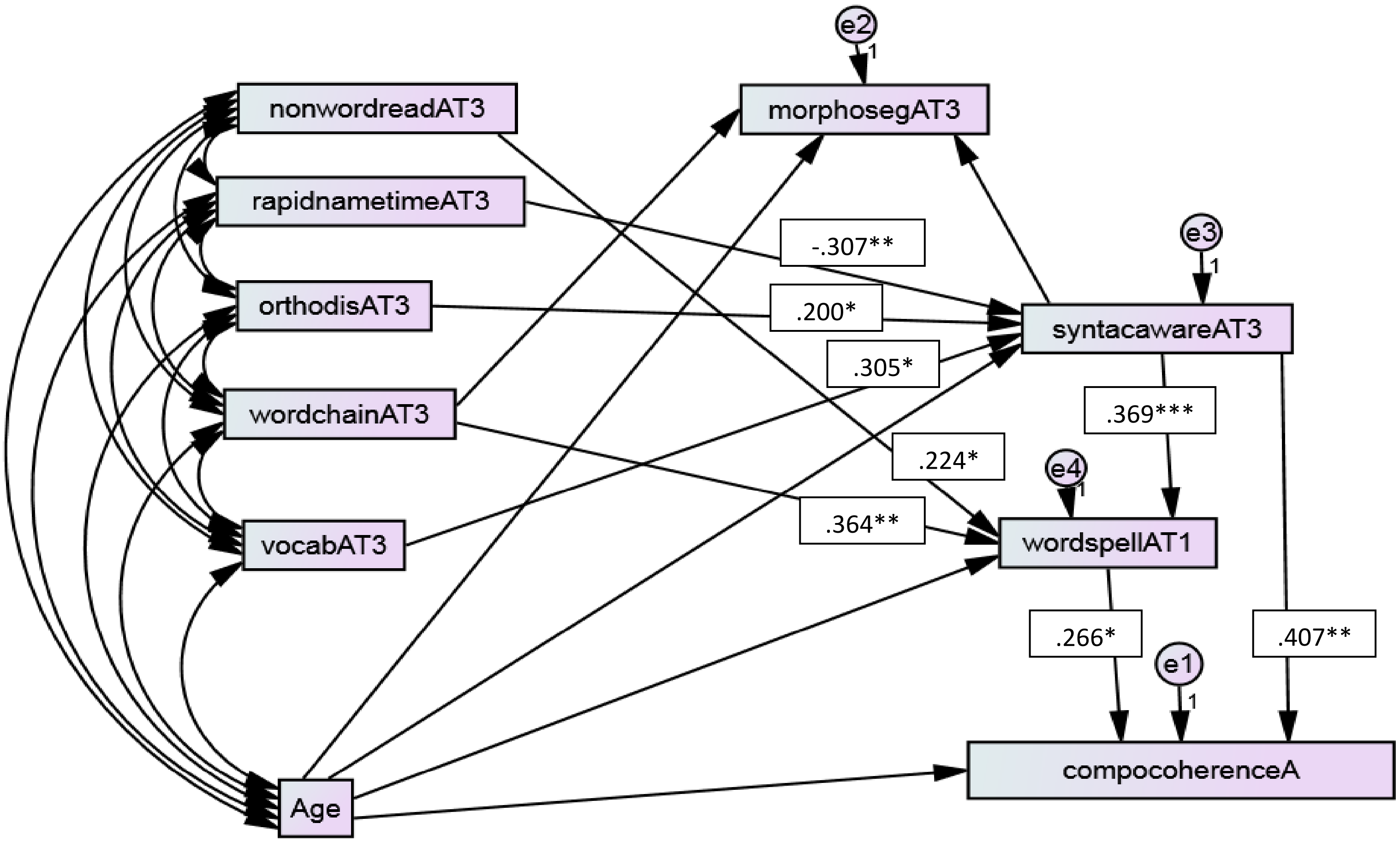
<table>
<tr><td colspan="8">Table 6.32 Regression analysis to investigate Time 3 predictors of Arabic composition coherence</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>decoding</td><td>.067</td><td>.061</td><td>F(1,68)= 4.447
p=.039</td><td>non-word reading</td><td>-.006-</td></tr>
<tr><td>2</td><td>word spelling</td><td>.341</td><td>.275</td><td>F(1,67)= 27.928
p=.000</td><td colspan="2">.468</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>word spelling</td><td>.340</td><td>.334</td><td colspan="3">F(1,68)= 34.386
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.341</td><td>.002</td><td colspan="3">F(1,67)=.170
p=.681</td></tr>
<tr><td rowspan="3">III</td><td>3</td><td>vocabulary</td><td>.365</td><td>.024</td><td>F(1,66)= 2.448
p=.122</td><td colspan="2">.134</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.400</td><td rowspan="2">.035</td><td rowspan="2">F(2,64)= 1.851
p=.165</td><td>syntactic awareness</td><td>.228</td></tr>
<tr><td>morphological segmentation</td><td>.137</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>Morpho-syntactic awareness</td><td>.395</td><td>.054</td><td colspan="3">F(2,65)= 2.878
p=.063</td></tr>
<tr><td>4</td><td>vocabulary</td><td>.400</td><td>.005</td><td colspan="3">F(1,64)=.502
p=.481</td></tr>
<tr><td rowspan="3">V</td><td>3</td><td>phonological awareness</td><td>.418</td><td>.019</td><td>F(1,63)= 2.015
p=.161</td><td>rapid naming</td><td>.177</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">orthographic processing</td><td rowspan="2">.429</td><td rowspan="2">.011</td><td rowspan="2">F(2,61)= .582
p=.562</td><td>orthographic discrimination</td><td>.024</td></tr>
<tr><td>word chain</td><td>-.128</td></tr>
<tr><td rowspan="2">VI</td><td>3</td><td>orthographic processing</td><td>.411</td><td>.012</td><td colspan="3">F(2,62)=.615
p=.544</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.429</td><td>.018</td><td colspan="3">F(1,61)= 1.904
p=.173</td></tr>
</table>

Figure 6.28 Path diagram to show the relations between skills from Time 3 variables to Time 4 Arabic composition coherence



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$.

Figure 6.29 Path diagram to show the relations between skills from Time 3 variables to Time 4 Arabic composition coherence



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p$ < .001. (Only estimates that are related to Coherence are shown.)

English Composition Coherence

Time 1 Variables

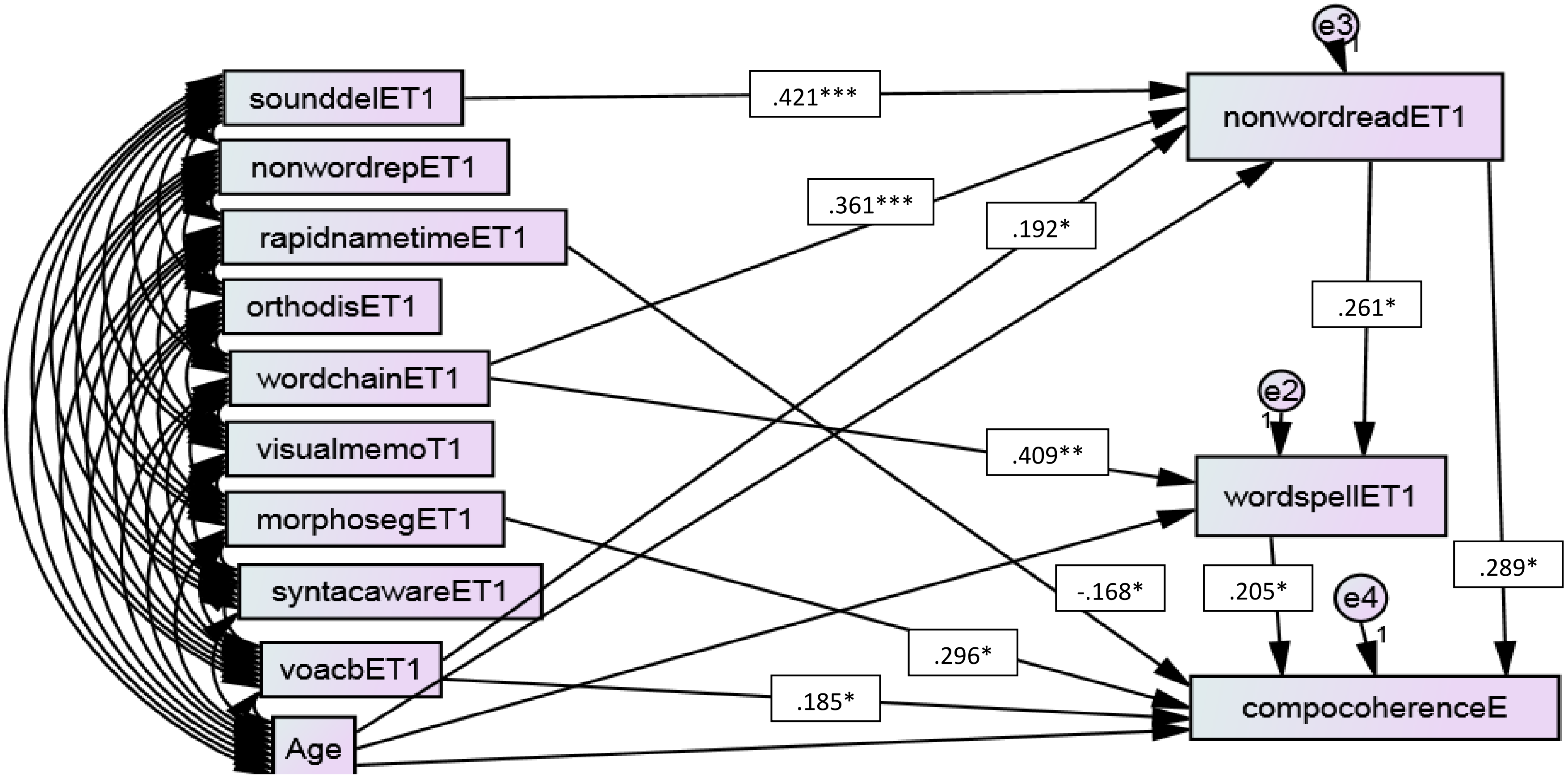
When investigating variance by measures of Time 1 on English Composition Coherence, a set of regressing analysis was conducted. For each set of these analyses, Time 4 English Composition Coherence was the dependent variable. The independent variables were Time 1 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The results in Table 6.33 show that after controlling for age, decoding explained 43% of variability, then word spelling added 6%. When word spelling was entered first, it explained 29% while decoding added 20%. When controlling for the previous variables, vocabulary explained 6% of variance. When morpho-syntactic awareness was entered before vocabulary, it explained 15% of variance (and vocabulary was insignificant) and when entered after, it explained 9%. Both phonological awareness and orthographic processing were insignificant. This shows that the main Time 1 predictors of English composition coherence are word spelling, decoding, and morpho-syntactic processing.

Path Analyses

Based on results from Chapter 5 (see Model 5.6); the first model included paths from Time 1 sound deletion and word chain to Time 1 decoding and from Time 1 decoding and word chain to Time 1 word spelling. Finally, we added paths from all Time 1 exogenous variables, in addition to Time 1 word spelling and decoding to Time 4 Composition Coherence. We allowed the Time 1 (exogenous) variables to covary. Age was controlled for as previously discussed. The initial hypothesised model provided a good fit to the data set: $\chi2$ (14) = 11.045, p=.682, CFI=1.000, RMSEA=.000, PCLOSE=.808. To build a simplified model, we used variables with significant paths only. The model was a good fit to the data set: $\chi2$ (14) = 17.615 p=.613, CFI=1.000, RMSEA=.000 PCLOSE=.780 (See Figure 6.30). The model shows that word spelling, decoding, vocabulary, morphological segmentation and RAN are directly related to Time 1 English composition coherence. It also shows that word chain is indirectly related to English composition coherence via word spelling. (Note that when trying to build another model with morpho-syntactic skills as mediators we had the same results).

<table>
<tr><td colspan="7">Table 6.33 Regression analysis to investigate Time 1 predictors of English Composition Coherence</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>decoding</td><td>.432</td><td>.432</td><td>F(1,68)= 51.712
p=.000</td><td>non-word reading</td><td>.267</td></tr>
<tr><td>2</td><td>word spelling</td><td>.496</td><td>.064</td><td>F(1,67)= 8.437
p=.005</td><td colspan="2">.161</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>word spelling</td><td>.294</td><td>.294</td><td colspan="3">F(1,68)= 28.377
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.496</td><td>.201</td><td colspan="3">F(1,67)= 26.702
p=.000</td></tr>
<tr><td rowspan="3">III</td><td>3</td><td>vocabulary</td><td>.581</td><td>.085</td><td>F(1,66)= 13.418
p=.000</td><td colspan="2">.123</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.665</td><td rowspan="2">.085</td><td rowspan="2">F(2,64)= 8.086
p=.001</td><td>syntactic awareness</td><td>.119</td></tr>
<tr><td>morphological segmentation</td><td>.277</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>Morpho-syntactic awareness</td><td>.648</td><td>.153</td><td colspan="3">F(2,65)= 14.089
p=.000</td></tr>
<tr><td>4</td><td>vocabulary</td><td>.665</td><td>.017</td><td colspan="3">F(1,64)= 3.298
p=.074</td></tr>
<tr><td rowspan="6">V</td><td rowspan="3">3</td><td rowspan="3">phonological awareness</td><td rowspan="3">.680</td><td rowspan="3">.015</td><td rowspan="3">F(3,61)= .962
p=.417</td><td>sound deletion</td><td>-.062-</td></tr>
<tr><td>rapid naming</td><td>-.090-</td></tr>
<tr><td>non-word repetition</td><td>.055</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">orthographic processing</td><td rowspan="3">.691</td><td rowspan="3">.010</td><td rowspan="3">F(3,58)=.636
p=.595</td><td>orthographic discrimination</td><td>-.014-</td></tr>
<tr><td>word chain</td><td>.116</td></tr>
<tr><td>visual memory</td><td>.090</td></tr>
<tr><td rowspan="2">VI</td><td>3</td><td>orthographic processing</td><td>.679</td><td>.014</td><td colspan="3">F(3,61)=.870
p=.462</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.691</td><td>.012</td><td colspan="3">F(3,58)= .722
p=.543</td></tr>
</table>

Figure 6.30 Modified Path diagram to show the relations between skills from Time 1 variables to Time 4 English composition coherence.



Note. Numbers in the figure are standardised regression weights. ∗*p*=.05. ∗∗*p*=.01.∗∗∗*p* < .001.

Time 2 Variables

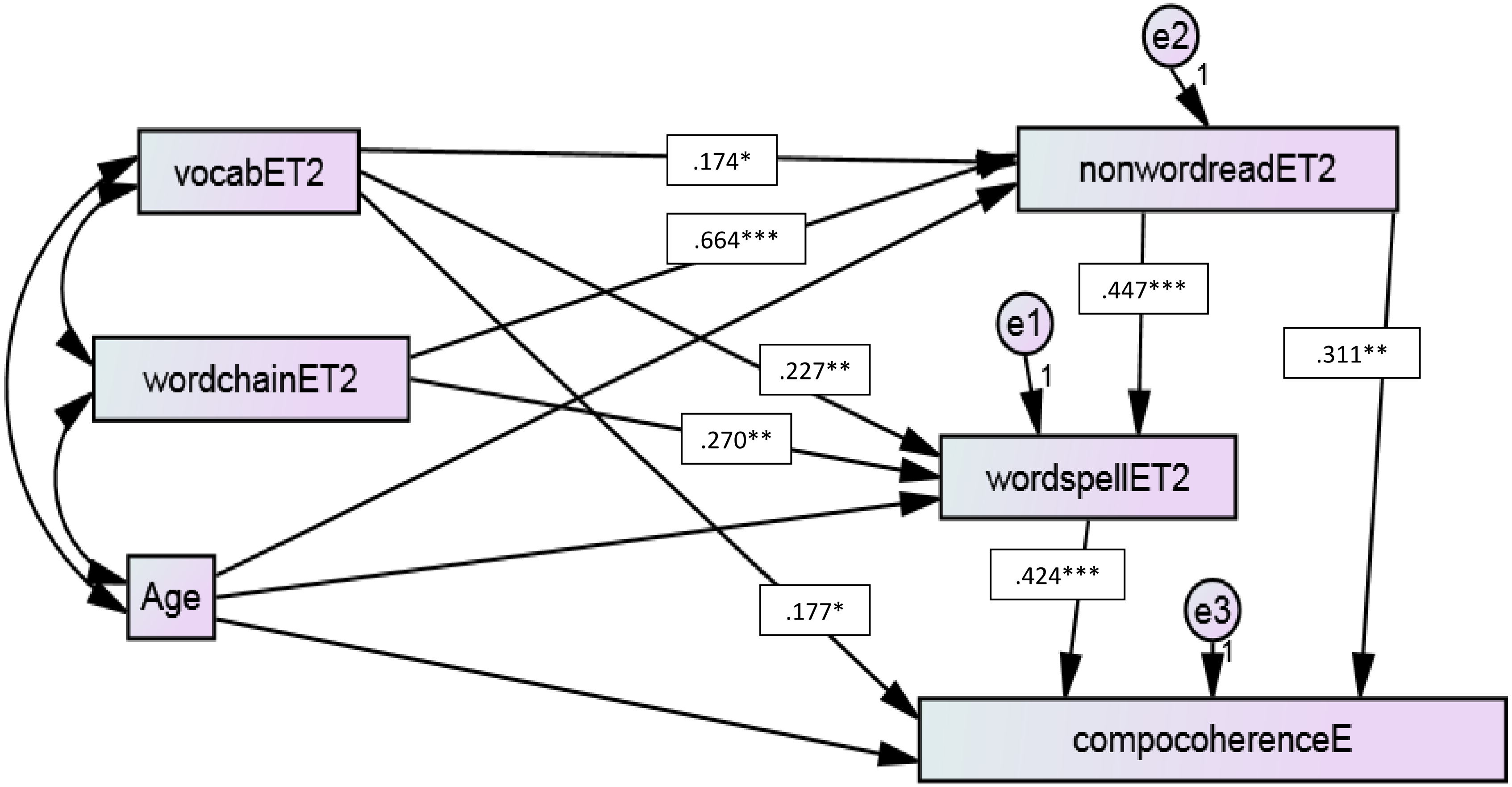
The variance by measures of Time 2 on English Composition Coherence was tested with a set of regressing analysis. For each set of these analyses, Time 4 English composition coherence was the dependent variable. The independent variables were Time2 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.34 shows that, after controlling for age, when decoding was entered before word spelling it explained 49 % of variability while word spelling explained 12%. When word spelling was entered first, it explained 55% while decoding explained 5%. Orthographic processing was insignificant while vocabulary added 2% of unique variability. These results show that the main Time 2 predictors of English composition coherence are decoding and word spelling, and vocabulary.

Path Analyses

The first model included all paths from Time 2 vocabulary and word chain to Time 2 decoding (based on previous results), and from Time 2 decoding, vocabulary and word chain to Time 2 word spelling. Finally, we added paths from Time 2, decoding, vocabulary, word chain and word spelling to Time 4 composition coherence. We allowed the Time 2 (exogenous) variables to covary. Age was controlled for as previously discussed. The model that resulted was saturated and did not provide a good fit. Therefore, based on regression results, the path from word chain to composition coherence was deleted and the model provided a good fit to the data set: $\chi 2$ (1) = .013, p=.909, CFI=1.000, RMSEA=.000, PCLOSE=.917 (See Figure 6.31). The path analysis confirms the result of regression that the main Time 2 predictors of English composition coherence are word spelling, decoding, and vocabulary. Decoding, word chain, and vocabulary have indirect prediction paths via word spelling.

<table>
<tr><th colspan="8">Table 6.34 Regression analysis to investigate Time 2 predictors of English Composition Coherence</th></tr>
<tr><th colspan="2"></th><th>Variables</th><th>R^2</th><th>R^2 change</th><th>Sig R^2 change</th><th colspan="2">Final Beta</th></tr>
<tr><td rowspan="2">I</td><td>1</td><td>decoding</td><td>.485</td><td>.485</td><td>F(1,68)= 64.045
p=.000</td><td>non-word reading</td><td>.318</td></tr>
<tr><td>2</td><td>word spelling</td><td>.601</td><td>.116</td><td>F(1,67)= 19.396
p=.000</td><td colspan="2">.428</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>word spelling</td><td>.552</td><td>.552</td><td colspan="3">F(1,68)=83.806
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.601</td><td>.049</td><td colspan="3">F(1,67)=8.150
p=.006</td></tr>
<tr><td rowspan="2">III</td><td>3</td><td>vocabulary</td><td>.624</td><td>.023</td><td>F(1,66)=4.067
p=.048</td><td colspan="2">.177</td></tr>
<tr><td>4</td><td>orthographic processing</td><td>.624</td><td>.000</td><td>F(1,65)=.012
p=.913</td><td>word chain</td><td>-.013-</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>orthographic processing</td><td>.601</td><td>.000</td><td colspan="3">F(1,66)=.015
p=.902</td></tr>
<tr><td>4</td><td>vocabulary</td><td>.624</td><td>.023</td><td colspan="3">F(1,65)=4.002
p=.050</td></tr>
</table>

Figure 6.31 Path diagram to show the relations between skills from Time 2 variables to Time 4 English composition coherence.



Note. Numbers in the figure are standardised regression weights. ∗*p*=.05. ∗∗*p*=.01.∗∗∗*p* < .001.

Time 3 Variables

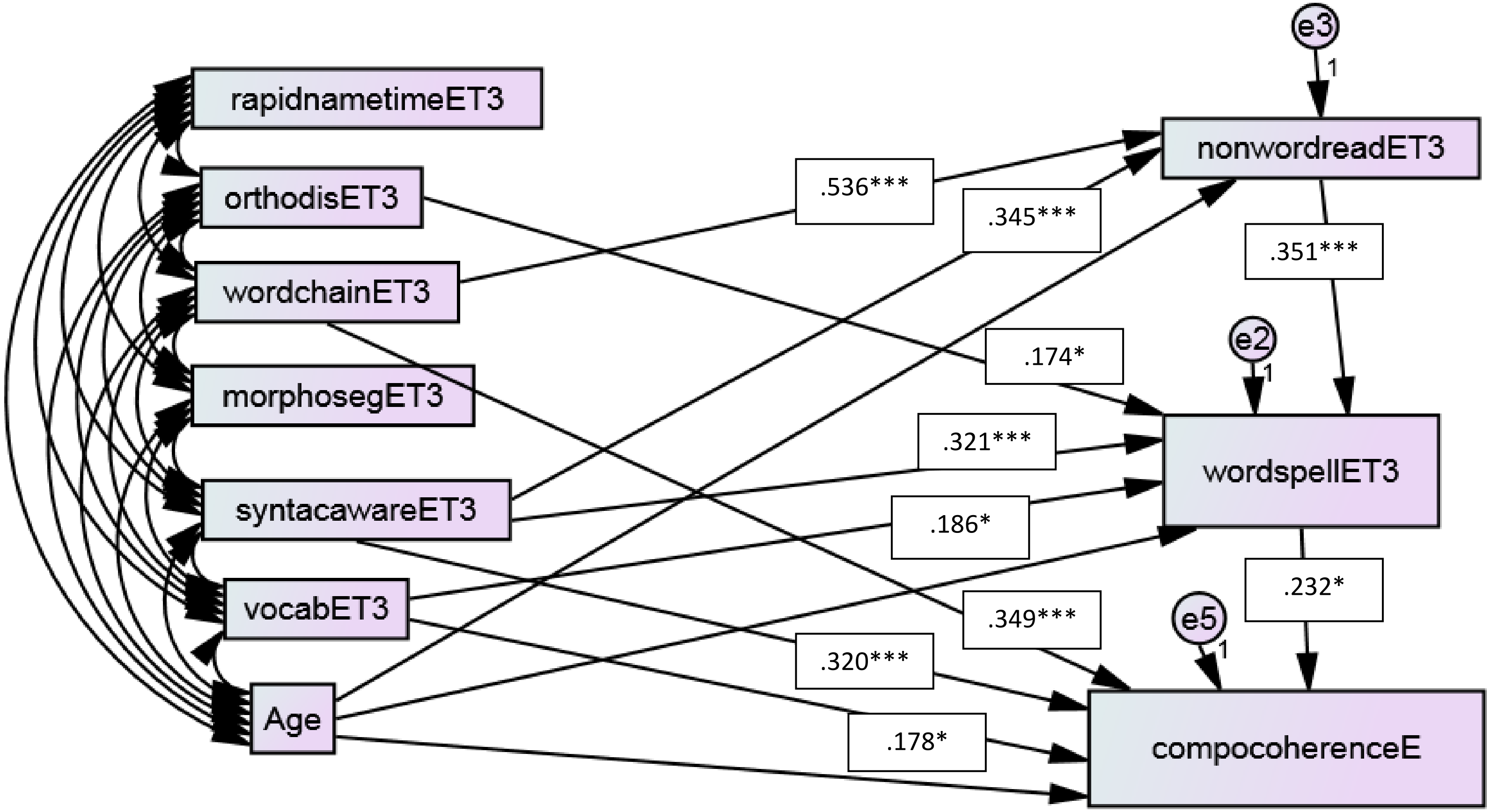
Finally, the variance made by measures of Time 3 on each of the English Composition Coherence was tested with a set of regressing analysis. For each set of these analyses, Time 4 English Composition Coherence was the dependent variable. The independent variables were Time 3 decoding skills, word spelling, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. Table 6.35 shows that, after controlling for age, when decoding was entered before word spelling it explained 46% of variability while word spelling explained 13%. When word spelling was entered first, it explained 51% while decoding explained 8%. When vocabulary was entered before morpho-syntactic skills, it explained 4% of variance, and morpho-syntactic skills explained 5%. When morpho-syntactic skill was entered first, it explained 7% and vocabulary 3%. Phonological processing was insignificant. When orthographic processing was entered before phonological processing, it explained 4% and when entered after, it explained 5%. It could be concluded then that the main Time 3 predictors of English composition coherence are word spelling, decoding, morpho-syntactic processing, vocabulary and orthographic processing.

Path Analyses

Based on previous results, the first model included paths from Time 3 word chain and syntactic awareness to Time 3 decoding, and from Time 3 decoding, orthographic discrimination, syntactic awareness and word chain to Time 3 word spelling. Finally, we added paths from all Time 3 exogenous variables, in addition to word spelling and decoding, to Time 4 composition coherence. We allowed the Time 3 (exogenous) variables to covary. Age was controlled for as previously discussed. The model was good fit $\chi 2$ (7) = 7.316, p =.397, CFI=.999, RMSEA=.025, PCLOSE=.516.To build a simplified model we used significant paths only. The final model was a good fit to the data set: $\chi 2$ (11) = 13.266, p=.276, CFI=.992, RMSEA=.054, PCLOSE=.420 (See Figure 6.32). The final model confirms the previous finding that Time 3 predictors of English composition coherence are word spelling, syntactic awareness, vocabulary and orthographic processing. It also adds that vocabulary and decoding are indirectly related to English composition coherence via word spelling. When trying to build a model with morpho-syntactic skills as mediators, the model was not a good fit, even after deleting insignificant paths: $\chi2$ (14) = 24.988, p=.035, CFI=.961, RMSEA=.106, PCLOSE=.093.

<table>
<tr><td colspan="8">Table 6.35 Regression analysis to investigate Time 3 predictors of English Composition Coherence</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>decoding</td><td>.459</td><td>.459</td><td>F(1,68)= 57.724
p=.000</td><td>non-word reading</td><td>.091</td></tr>
<tr><td>2</td><td>word spelling</td><td>.587</td><td>.128</td><td>F(1,67)= 20.681
p=.000</td><td colspan="2">.200</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>word spelling</td><td>.506</td><td>.506</td><td colspan="3">F(1,68)= 69.737
p=.000</td></tr>
<tr><td>2</td><td>decoding</td><td>.587</td><td>.080</td><td colspan="3">F(1,67)= 13.033
p=.001</td></tr>
<tr><td rowspan="3">III</td><td>3</td><td>vocabulary</td><td>.625</td><td>.038</td><td>F(1,66)= 6.644
p=.012</td><td colspan="2">.148</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.677</td><td rowspan="2">.052</td><td rowspan="2">F(2,64)= 5.187
p=.008</td><td>syntactic awareness</td><td>.274</td></tr>
<tr><td>morphological segmentation</td><td>.054</td></tr>
<tr><td rowspan="2">IV</td><td>3</td><td>Morpho-syntactic awareness</td><td>.652</td><td>.065</td><td colspan="3">F(2,65)= 6.120
p=.004</td></tr>
<tr><td>4</td><td>vocabulary</td><td>.677</td><td>.025</td><td colspan="3">F(1,64)= 4.889
p=.031</td></tr>
<tr><td rowspan="3">V</td><td>3</td><td>phonological awareness</td><td>.682</td><td>.005</td><td>F(1,63)= .919
p=.342</td><td>rapid naming</td><td>-.115-</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">orthographic processing</td><td rowspan="2">.727</td><td rowspan="2">.045</td><td rowspan="2">F(2,61)= 5.058
p=.009</td><td>orthographic discrimination</td><td>-.086-</td></tr>
<tr><td>word chain</td><td>.303</td></tr>
<tr><td rowspan="2">VI</td><td>3</td><td>orthographic processing</td><td>.718</td><td>.042</td><td colspan="3">F(2,62)= 4.576
p=.014</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.727</td><td>.008</td><td colspan="3">F(1,61)= 1.873
p=.176</td></tr>
</table>

Figure 6.32 Path diagram to show the relations between skills from Time 3 variables to Time 4 English composition coherence.



Note. Numbers in the figure are standardised regression weights. *p=.05. **p=.01.***p < .001.

Longitudinal Results for Arabic Word Reading and Text Reading Fluency

Table 6.36 demonstrates correlations of Time 1 Arabic measures and the non-language measures with Time 2 and Time 3 Arabic word reading and text reading fluency.

Table 6.36 Correlations of Time 1 for Arabic measures and the non-language measures with both Time 2 and Time 3 reading measures

Time 1 Measures \ Time 2 & 3 measures	Time 2 Word Reading	Time 2 Text reading Fluency	Time 3 Word Reading	Time 3 Text Reading Fluency
word reading	.806**	.676**	.588**	.724**
text reading fluency	.788**	.860**	.621**	.843**
word spelling	.743**	.636**	.604**	.688**
Non-word Reading	.677**	.490**	.633**	.579**
Vocabulary	.260*	.330**	.131	.369**
Sound Deletion	.657**	.562**	.560**	.587**
Rapid Naming	-.375**	-.541**	-.159	-.509**
Non-word Repetition	.307**	.253*	.110	.232
Orthographic Discrimination	.032	.135	.074	.082
Word Chain	.383**	.248*	.445**	.252*
Visual Memory	.478**	.291*	.300*	.304*
Syntactic Awareness	.587**	.512**	.443**	.525**
Morphological Segmentation	.605**	.432**	.373**	.496**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

The table shows that Time 2 Arabic word reading correlated with Time 1 decoding, word spelling, phonological processing skills, orthographic processing skills (except for orthographic discrimination), and morpho-syntactic skills. Similarly, Time 3 word reading also correlated with Time 1 decoding, word spelling, orthographic processing skills (except for orthographic discrimination), and morpho-syntactic skills. However, the only phonological processing skills it correlated with, was Time 1 sound deletion. Time 2 text reading fluency correlated with Time 1 decoding, word spelling, phonological processing skills, orthographic processing skills (except for orthographic discrimination), and morpho-syntactic skills. Time 3 text reading fluency correlated with Time 1 decoding, word spelling, vocabulary, phonological processing skills (except for phonological memory), orthographic processing skills (except for orthographic discrimination), and morpho-syntactic skills. Regression analyses were performed to investigate variance by each measure of Time1. The dependent variables in the regression sets were Time 2 Arabic word reading Arabic, Time 3 Arabic word reading, Time 2 Arabic text reading fluency, and Time 3 Arabic text reading fluency. We conducted a simple regression-based path model of the longitudinal relations between the observed variables of Time 1 in the prediction of each of the abovementioned measures. The procedures followed were similar to those conducted in both Chapter 5 and in this chapter.

Time 2 Arabic Word Reading

In the first set of analyses (see Tables 6.37 and 6.38), Time 2 Arabic word reading was the dependent variable. The independent variables were Time 1 decoding skills, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The final beta scores show that the main predictor was decoding (beta score = .327), followed by syntactic awareness (beta score = .171). The data in Table 6.37 also show that, after controlling for age, vocabulary explained 7% while decoding explained 42% variance of Arabic word reading. When decoding was entered first, it explained 48% of variance while became insignificant. After controlling for age, decoding and vocabulary; both phonological processing and orthographic processing still add unique variance in word reading. When phonological awareness was entered before orthographic processing, it explained 11% while orthographic processing explained 5% of variance. When the order was reversed, orthographic processing explained 10% of unique variability while phonological processing explained 6%. After controlling for the previous variables, morpho-syntactic awareness was insignificant. In Table 8.38 the data show that when controlling for age, decoding, phonological processing and orthographic processing, vocabulary and morpho-syntactic processing did not add any unique variance. It also shows that after controlling for age and decoding, orthographic processing added 11% of unique variance, then phonological processing added 8%. When the order of entry was reversed, phonological processing explained 14% of variance and orthographic processing added 5% more. Results from this set of analyses indicate that Time 1 predictors of Time 2 Arabic word reading are Time 1 decoding, orthographic processing and phonological processing skills.

Time 2 Arabic Word Reading Model (with Time 1 predictors)

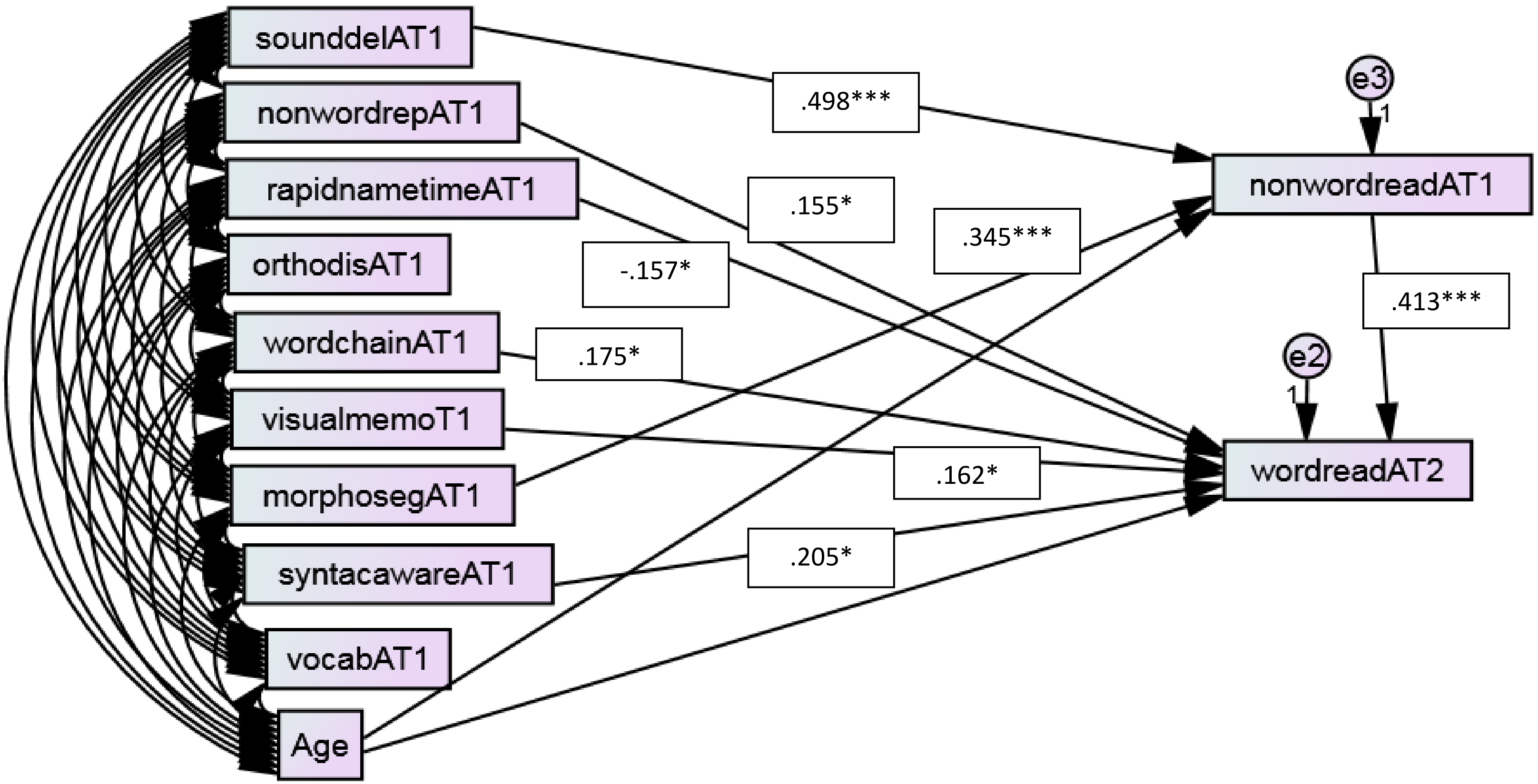
The first model included all possible correlations between measures at Time 1, and with all possible paths from Time 1 variables in addition to Time 1 decoding (that was used as mediator in the model) to Time 2 word reading and, from Time 1 morpho-syntactic skills and phonological skills (based on regression findings) to Time 1 decoding. We allowed the Time 1 (exogenous) variables to covary. Age was controlled for by having paths to word decoding and word reading. Then we allowed it to covary with all the other exogenous variables. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (1) = 1.466, p=.226, CFI=.998, RMSEA=.082, PCLOSE=.226. To build a simpler model, we used variables with significant paths only (See Figure 6.33) The model provided a good fit to the data set: $\chi 2$ (11) = 10.474, p=.488, CFI=1.000, RMSEA=.000, PCLOSE=.633. The model confirms the previous findings that phonological processing (sound deletion) and morpho-syntactic processing (morphological segmentation) predict decoding. It also confirms that decoding, orthographic processing (visual memory and word chain) and phonological processing (RAN and phonological memory are directly related to word reading, and phonological awareness is indirectly related to it via decoding) predict Time 2 word reading. In addition, the model indicates that Time 1 morpho-syntactic processing (syntactic awareness is directly related to word reading while morphological segmentation is indirectly related to it via decoding) can predict Time 2 word reading.

<table>
<tr><td colspan="8">Table 6.37 Regression analysis to investigate Time 1 predictors of Time 2 Arabic word reading</td></tr>
<tr><td colspan="2"></td><td>Variables</td><td>R^2</td><td>R^2 change</td><td>Sig R^2 change</td><td colspan="2">Final Beta</td></tr>
<tr><td rowspan="2">I</td><td>1</td><td>vocabulary</td><td>.068</td><td>.066</td><td>F(1,68)=4.833
P=.031</td><td colspan="2">-.003</td></tr>
<tr><td>2</td><td>decoding</td><td>.486</td><td>.418</td><td>F(1,67)=54.550
P=.000</td><td colspan="2">.327</td></tr>
<tr><td rowspan="2">II</td><td>1</td><td>decoding</td><td>.459</td><td>.457</td><td colspan="3">F(1,68)= .57.522
P=.000</td></tr>
<tr><td>2</td><td>vocabulary</td><td>.486</td><td>.027</td><td colspan="3">F(1,67)=3.529
P=.065</td></tr>
<tr><td rowspan="6">III</td><td rowspan="3">3</td><td rowspan="3">phonological processing</td><td rowspan="3">.596</td><td rowspan="3">.110</td><td rowspan="3">F(3,64)=5.786
P=.001</td><td>sound deletion</td><td>.113</td></tr>
<tr><td>rapid naming</td><td>-.116</td></tr>
<tr><td>non-word repetition</td><td>.150</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">orthographic processing</td><td rowspan="3">.644</td><td rowspan="3">.048</td><td rowspan="3">F(3,61)=2.743
P=.051</td><td>orthographic discrimination</td><td>.063</td></tr>
<tr><td>word chain</td><td>.157</td></tr>
<tr><td>visual memory</td><td>.125</td></tr>
<tr><td rowspan="2">I
V</td><td>3</td><td>orthographic processing</td><td>.582</td><td>.095</td><td colspan="3">F(3,64)=4.868
P=.004</td></tr>
<tr><td>4</td><td>phonological awareness</td><td>.644</td><td>.062</td><td colspan="3">F=(3,61)=3.552
P=.019</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">5</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.663</td><td rowspan="2">.019</td><td rowspan="2">F(2,59)=1.700
P=.192</td><td>syntactic awareness</td><td>.171</td></tr>
<tr><td>morphological segmentation</td><td>.100</td></tr>
</table>

Table 6.38 Regression analysis to investigate Time 1 predictors of Time 2 Arabic word reading

		Variables	R^2	R^2 change	Sig R^2 change
I	1	decoding	.459	.457	F(1,68)= .57.522 P=.000
II	2	orthographic processing	.564	.105	F(3,65)=5.217 P=.003
	3	Phonological processing	.642	.077	F(3,62)=4.469 P=.007
III	2	Phonological processing	.594	.135	F(3,65)=7.180 P=.000
	3	orthographic processing	.642	.048	F(3,62)=2.759 P=.050
IV	4	Vocabulary	.644	.002	F(1,61)=.386 P=.537
	5	Morpho-syntactic awareness	.663	.019	F(2.59)=1.700 P=.192
V	4	Morpho-syntactic awareness	.663	.022	F(2,60)=1.929 P=.154
	5	Vocabulary	.663	.000	F(1,59)=.001 P=.972

Figure 6.33 Path diagram to show the concurrent relations between variables from Time 1 to Time 2 Arabic Word Reading.



Note. Numbers in the figure are standardised regression weights. ∗*p*=.05. ∗∗*p*=.01.∗∗∗*p* < .001.

Time 3 Arabic Word Reading

In the second set of analyses (see Tables 6.39 and 6.40), Time 3 Arabic word reading was the dependent variable. The independent variables were Time 1 decoding skills, vocabulary, phonological processing, orthographic processing and morpho-syntactic skills. The final beta scores show that the main predictor was decoding (beta score = .430), followed by word chain (beta score = .276). The data in Table 6.39 also show that, after controlling for age, vocabulary was insignificant. When decoding was entered first, it explained 41% of variance. After controlling for age, decoding and vocabulary; phonological processing was insignificant, while orthographic processing still adds 8% of unique variance in word reading. After controlling for the previous variables, morpho-syntactic awareness was insignificant. In Table 6.40 the data show that when controlling for age and decoding; orthographic processing explained 8% of unique variance while phonological processing vocabulary and morpho-syntactic processing did not add any unique variance. Results from this set of analyses indicate that Time 1 predictors of Time 3 Arabic word reading are Time 1 decoding and orthographic processing skills.

Time 3 Arabic Word Reading Model (with Time 1 predictors)

The first model included all possible correlations between measures at Time 1, and with all possible paths from Time 1 variables in addition to Time 1 decoding (that was used as mediator in the model) to Time 3 word reading and, from Time 1 morpho-syntactic skills and phonological skills (based on regression findings) to Time 1 decoding. We allowed the Time 1 (exogenous) variables to covary. Age was controlled for by having paths to word decoding and word reading. Then we allowed it to covary with all the other exogenous variables. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (1) = 1.466, p=.226, CFI=.998, RMSEA=.082, PCLOSE=.226. To build a simpler model, we used variables with significant paths only (See Figure 6.34). The model provided a good fit to the data set: $\chi 2$ (14) = 11.968, p=.609, CFI=1.000, RMSEA=.000, PCLOSE=.752. The model confirms the previous findings that phonological processing (sound deletion) and morpho-syntactic processing (morphological segmentation) predict decoding. It also confirms that decoding and orthographic processing (word chain) predict Time 3 word reading. In addition, the model indicates that Time 1 morpho-syntactic processing (syntactic awareness is directly related to word reading while morphological segmentation is indirectly related to it via decoding) can predict Time 3 word reading.

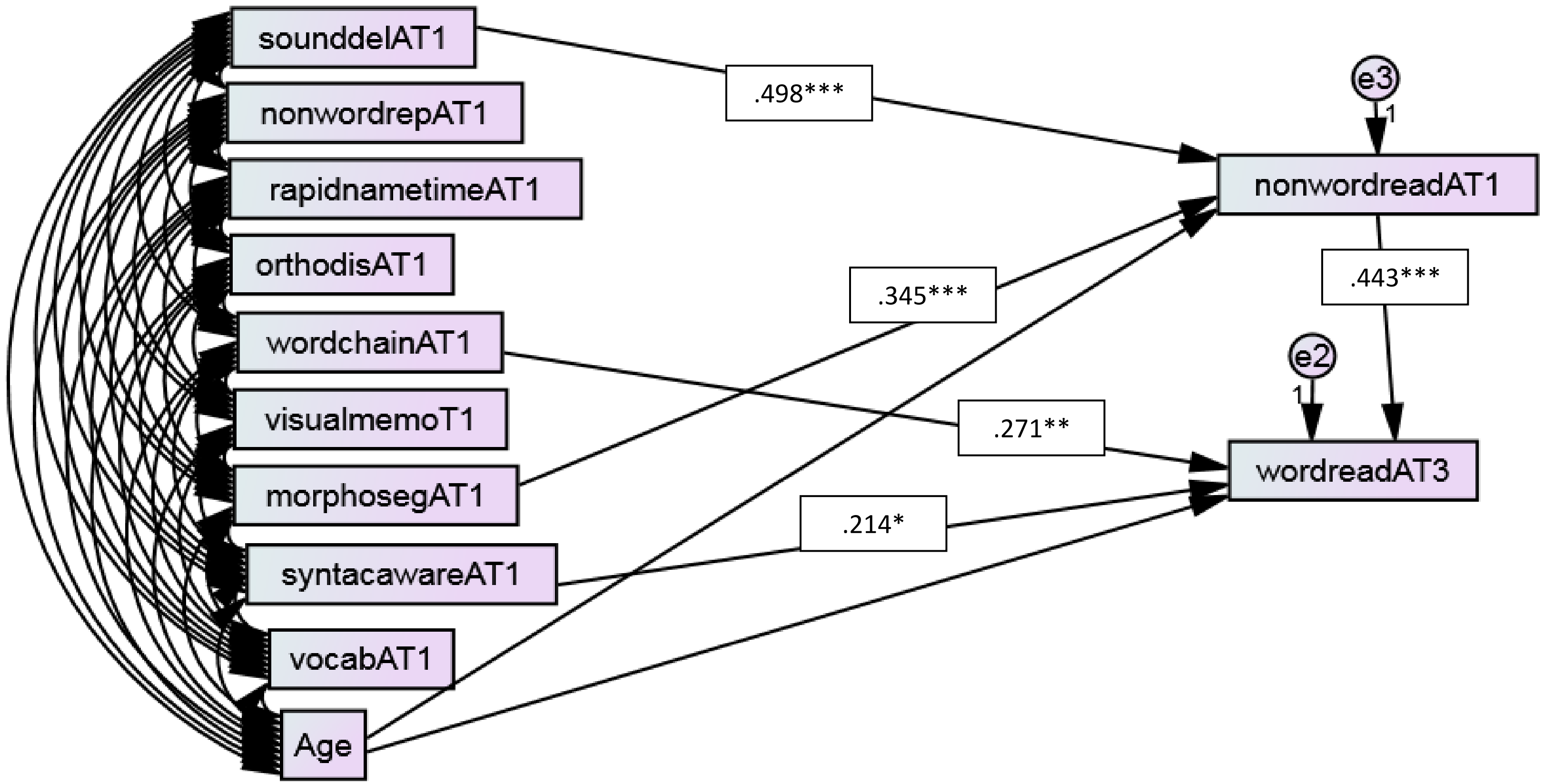
Table 6.39 Regression analysis to investigate Time 1 predictors of Time 3 Arabic word reading

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	vocabulary	.023	.021	F(1,68)=1.474 P=.229	.018	
	2	decoding	.414	.391	F(1,67)=44.775 P=.000	.430	
II	1	decoding	.411	.409	F(1,68)=47.269 P=.000		
	2	vocabulary	.414	.003	F(1,67)=.368 P=.546		
III	3	phonological processing	.448	.034	F(3,64)=1.302 P=.282	sound deletion	.090
						rapid naming	.028
						non-word repetition	.041
	4	orthographic processing	.504	.056	F(3,61)=2.279 P=.088	orthographic discrimination	.108
						word chain	.276
						visual memory	.070
IV	3	orthographic processing	.492	.078	F(3,64)=3.261 P=.027		
	4	phonological awareness	.504	.012	F(3,61)=.478 P=.699		
	5	Morpho-syntactic awareness	.523	.020	F(2,59)=1.208 P=.306	syntactic awareness	.190
						morphological segmentation	-.116

Table 6.40 Regression analysis to investigate Time 1 predictors of Time 3 Arabic word reading

		Variables	R^2	R^2 change	Sig R^2 change
I	1	decoding	.411	.409	F(1,68)=47.269 P=.000
II	2	orthographic processing	.488	.077	F(3,65)=3.270 P=.027
	3	Phonological processing	.502	.014	F(3,62)=.573 P=.635
III	2	Phonological processing	.448	.036	F(3,65)=1.430 P=.242
	3	orthographic processing	.502	.055	F(3,62)=2,266 P= .090
IV	4	Vocabulary	.504	.001	F(1,61)=.183 P=.670
	5	Morpho-syntactic awareness	.523	.020	F(2,59)=1.208 P=.306
V	4	Morpho-syntactic awareness	.523	.021	F(2,60)=1.306 P=.278
	5	Vocabulary	.523	.000	F(1,59)=.029 P=.866

Figure 6.34 Path diagram to show the concurrent relations between variables from Time 1 to Time 2 Arabic Word Reading.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$.

Time 2 Text Reading Fluency

In the third set of analyses (see Table 6.41 and 6.42), Time 2 Arabic Text Reading Fluency was the dependent variable. The independent variables were Time 1 Arabic word reading, decoding, phonological processing, orthographic processing and morpho-syntactic awareness. The data in Table 6.41 shows that when controlling for age, word reading explained 46% of variance in text reading fluency. When controlling for age and word reading, decoding did not explain any unique variance of Arabic Text Reading Fluency, while vocabulary explained only 3% (that was almost significant). When controlling for the previous variables, phonological awareness explained 9% while orthographic processing was insignificant. When controlling for all the previous variables, morpho-syntactic awareness was insignificant. In Table 6.42 the data in section II show that when controlling for age and word reading, orthographic processing and vocabulary were insignificant while phonological awareness added 12% of unique variance. The data in section III show that (after controlling for age and word reading), phonological awareness added 11% of unique variance and both vocabulary and morpho-syntactic processing were insignificant. Results from this set of analyses indicate that Time 1 predictors of Time 2 Arabic text reading fluency are word reading and phonological processing.

Based on Arabic Word Reading Model (See Figure 6.35), the first model included all possible paths between measures at Time 1, and with paths from Time 1 sound deletion and morphological segmentation to decoding (that was used as mediator in the model), and from to Time 1 decoding, non-word repetition, RAN, word chain, visual memory, and syntactic awareness to Time 1 word reading (that was also used as a mediator). Finally, we had paths from all Time 1 variables (including decoding and word reading to Time 1 Text reading fluency. Age was controlled for as previously discussed. We allowed the Time 1 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (11) = 11.228, p=.424, CFI=.999, RMSEA=.017, PCLOSE=.573. To build a simpler model, we used variables with significant paths only (See Figure 6.36). The model provided a good fit to the data set: $\chi 2$ (22) = 22.243, p=.445, CFI=.999, RMSEA=.013, PCLOSE=.652. The model confirms the previous finding that Time 1 word reading and phonological processing (sound deletion and RAN) predict Time 2 Arabic text reading fluency. The model also shows that Time 1 RAN and word reading are directly related Text Reading Fluency, while RAN, visual memory, and syntactic awareness are indirectly related to it via word reading. Sound deletion and morphological segmentation are both indirectly related to fluency via decoding and hence word reading.

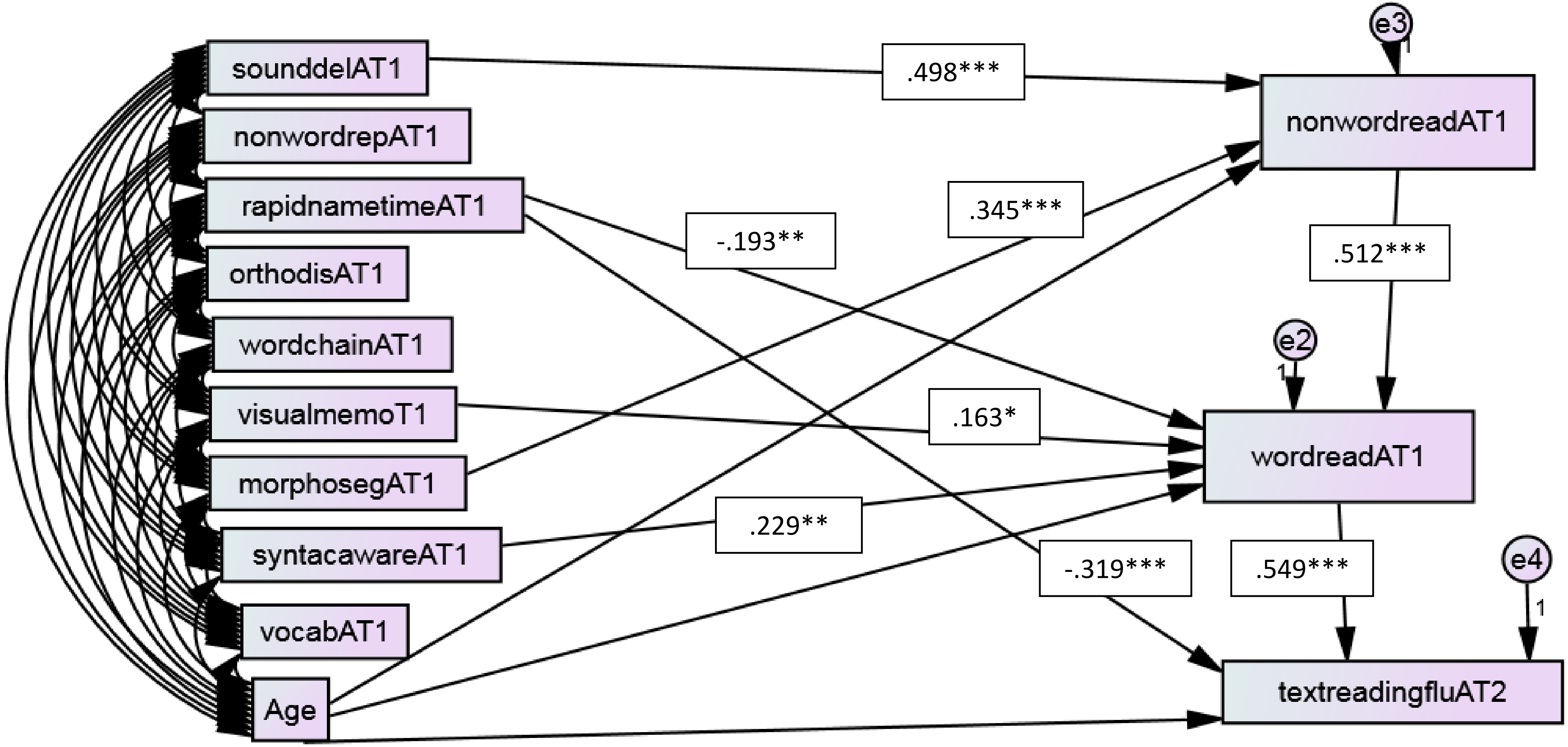
Table 6.41 Regression analysis to investigate Time 1 predictors of Time 2 Arabic Text Reading Fluency

		Variables	R^2	R^2 change	Sig R^2 change	Final Beta	
I	1	word reading	.458	.458	F(1,68)=57.476 P=.000	.409	
	2	decoding	.458	.000	F(1,67)=.005 P=.943	.028	
	3	vocabulary	.488	.030	F(1,66)=3.827 P=.055	.106	
II	4	phonological awareness	.579	.091	F(3,63)=.091 P=.006	sound deletion	.126
						rapid naming	-.292
						non-word repetition	.079
	5	orthographic processing	.589	.010	F(3,60)=.490 P=.691	orthographic discrimination	.068
						word chain	.050
						visual memory	-.105
III	4	orthographic processing	.497	.009	F(3,63)=.357 P=.784		
	5	phonological awareness	.589	.093	F(3,60)=4.509 P=.006		
IV	6	Morpho-syntactic awareness	.594	.005	F(2,58)=.346 P=.709	syntactic awareness	.102
						morphological segmentation	-.051

Table 6.42 Regression analysis to investigate Time 1 predictors of Time 2 Arabic Text Reading Fluency

		Variables	R^2	R^2 change	Sig R^2 change
I	1	word reading	.458	.458	F(1,68)=57.476 P=.000
II	2	orthographic processing	.464	.005	F(3,65)=.206 P=.892
	3	phonological awareness	.578	.114	F(3,62)=5.599 P=.002
	4	vocabulary	.589	.011	F(1,61)=1.680 P=.200
III	2	phonological processing	.569	.111	F(3,65)=5.556 P=.002
	3	vocabulary	.579	.010	F(1,64)=1.527 P=.221
	4	Morpho-syntactic processing	.583	.004	F(2,62)=.269 P=.765

Figure 6.35 Path diagram to show the concurrent relations between variables from Time 1 to Time 2 Arabic Text Reading Fluency.



Note. Numbers in the figure are standardised regression weights. $*p$=.05. $**p$=.01.$***p < .001$

Time 3 Text Reading Fluency

In the fourth set of analyses (see Tables 6.43 and 6.44), Time 3 Arabic Text Reading Fluency was the dependent variable. The independent variables were Time 1 Arabic word reading, decoding, phonological processing, orthographic processing and morpho-syntactic awareness. The data in Table 6.43 show that when controlling for age, word reading explained 53% of variance in text reading fluency. When controlling for age, and word reading, decoding did not explain any unique variance of Arabic text reading fluency, while vocabulary explained only 4%. When controlling for the previous variables, phonological awareness explained 6%, and orthographic processing was insignificant. When the order of entry was reversed (section III), orthographic processing was also significant. When controlling for all the previous variables, morpho-syntactic Awareness was insignificant. In Table 6.44 the data in section II show that when controlling for age and word reading, orthographic processing and vocabulary were insignificant while phonological awareness added 8% of unique variance. The data in section III show that when changing the order of entry (after controlling for age and word reading), again phonological awareness added 8% of unique variance and both vocabulary and morpho-syntactic processing were insignificant. Results from this set of analyses indicate that Time 1 predictors of Time 2 Arabic text reading fluency are word reading and phonological processing.

Based on Time 1 Arabic Word Reading Model (See Figure 5.3), the first model included all possible paths between measures at Time 1, and with paths from Time 1 sound deletion and morphological segmentation to decoding (that was used as mediator in the model), and from to Time 1 decoding, RAN, visual memory, and syntactic awareness to Time 1 word reading (that was also used as a mediator). Finally, we had paths from all Time 1 variables (including decoding and word reading to Time 3 text reading fluency. Age was controlled for as previously discussed. We allowed the Time 1 (exogenous) variables to covary. The initial hypothesised model provided a good fit to the data set: $\chi 2$ (13) = 14.489, p=.340, CFI=.995, RMSEA=.040, PCLOSE=.503. To build a simpler model, we used variables with significant paths only (See Figure 6.36). The model provided a good fit to the data set: $\chi 2$ (21) = 19.988, p=.522, CFI=1.000, RMSEA=.000, PCLOSE=.713.

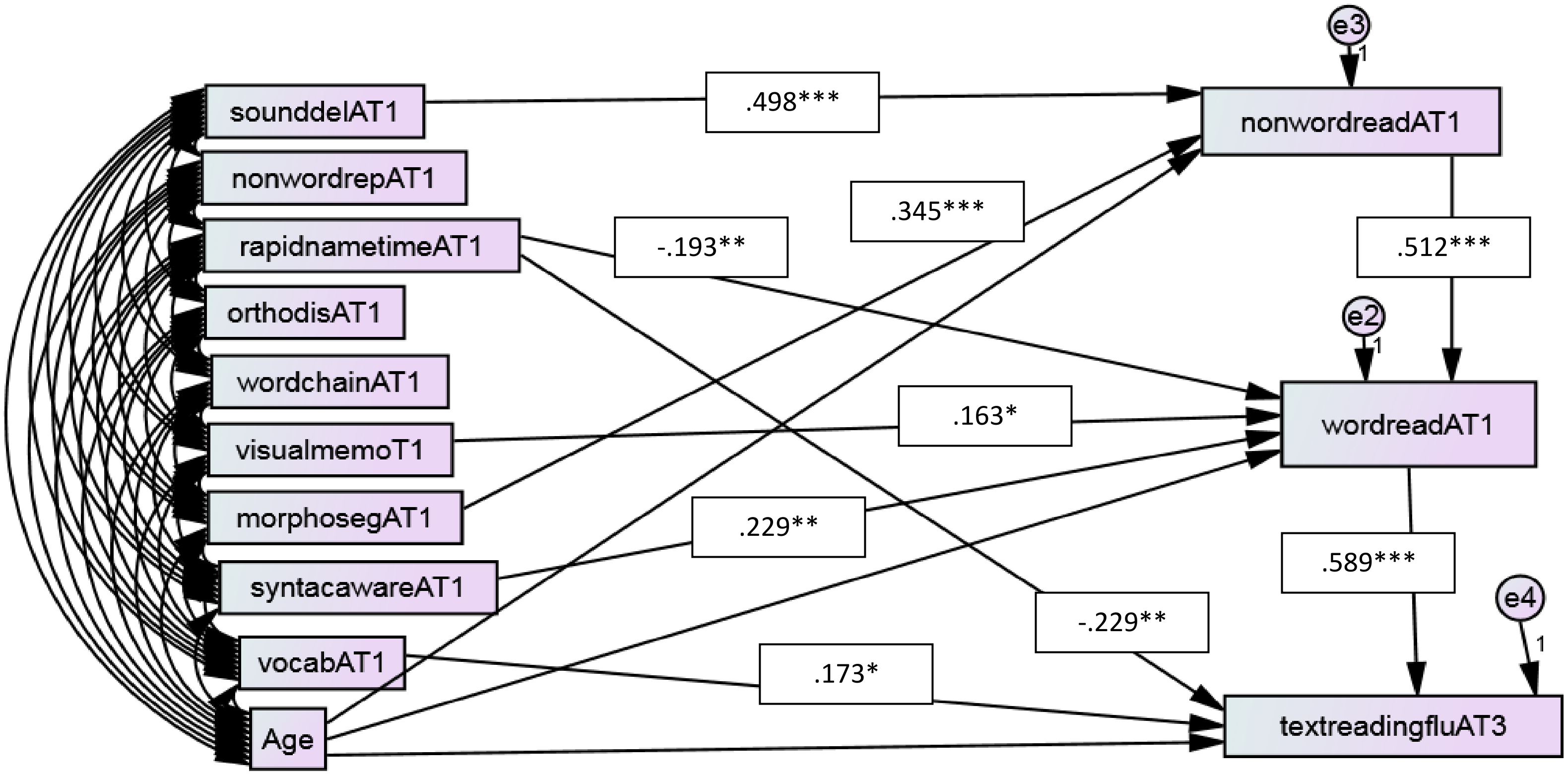
The model confirms the previous finding that Time 1 word reading and phonological processing (sound deletion and RAN) predict Time 2 Arabic text reading fluency. The model shows that Time 1 RAN and word reading are directly related text reading fluency, while RAN, visual memory, and syntactic awareness are indirectly related to it via word reading. Sound deletion and morphological segmentation are both indirectly related to fluency via decoding and hence word reading. What the model adds is that Time 1 vocabulary is directly related to Time 3 text reading fluency.

Table 6.43 Regression analysis to investigate Time 1 predictors of Time 3 Arabic Text Reading Fluency

<table>
<tr><th colspan="2"></th><th>Variables</th><th>R^2</th><th>R^2 change</th><th>Sig R^2 change</th><th colspan="2">Final Beta</th></tr>
<tr><td rowspan="3">I</td><td>1</td><td>word reading</td><td>.525</td><td>.525</td><td>F(1,68)=75.168
P=.000</td><td colspan="2">.455</td></tr>
<tr><td>2</td><td>decoding</td><td>.533</td><td>.007</td><td>F(1,67)=1.051
P=.309</td><td colspan="2">.141</td></tr>
<tr><td>3</td><td>vocabulary</td><td>.575</td><td>.042</td><td>F(1,66)=6.555
P=.013</td><td colspan="2">.171</td></tr>
<tr><td rowspan="6">II</td><td rowspan="3">4</td><td rowspan="3">phonological processing</td><td rowspan="3">.633</td><td rowspan="3">.058</td><td rowspan="3">F(3,63)=3.335
P=.025</td><td>sound deletion</td><td>.116</td></tr>
<tr><td>rapid naming</td><td>-.248</td></tr>
<tr><td>non-word repetition</td><td>.016</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">orthographic processing</td><td rowspan="3">.639</td><td rowspan="3">.006</td><td rowspan="3">F(3,60)=.346
P=.792</td><td>orthographic discrimination</td><td>-.003</td></tr>
<tr><td>word chain</td><td>-.006</td></tr>
<tr><td>visual memory</td><td>-.091</td></tr>
<tr><td rowspan="2">III</td><td>4</td><td>orthographic processing</td><td>.578</td><td>.003</td><td colspan="3">F(3,63)=.166
P=.919</td></tr>
<tr><td>5</td><td>phonological processing</td><td>.639</td><td>.061</td><td colspan="3">F(3,60)=3.392
P=.024</td></tr>
<tr><td rowspan="2">I
V</td><td rowspan="2">6</td><td rowspan="2">Morpho-syntactic awareness</td><td rowspan="2">.639</td><td rowspan="2">.000</td><td rowspan="2">F(2,58)=.004
P=.996</td><td>syntactic awareness</td><td>.006</td></tr>
<tr><td>morphological segmentation</td><td>-.010</td></tr>
</table>

Table 6.44 Regression analysis to investigate Time 1 predictors of Time 3 Arabic Text Reading Fluency					
		Variables	R^2	R^2 change	Sig R^2 change
I	1	word reading	.525	.525	F(1,68)=75.168 P=.000
II	2	orthographic processing	.527	.002	F(3,65)=.083 P=.969
	3	phonological processing	.610	.083	F(3,62)=4.418 P=.007
	4	Vocabulary	.632	.022	F(1,61)=3.628 P=.062
III	2	phonological processing	.603	.078	F(3,65)=4.241 P=.008
	3	Vocabulary	.624	.021	F(1,64)=3.631 P=.061
	4	Morpho-syntactic processing	.624	.000	F(2,62)=.008 P=.993

Figure 6.36 Path diagram to show the concurrent relations between variables from Time 1 to Time 3 Arabic Word Reading.



Note. Numbers in the figure are standardised regression weights. ∗*p*=.05 ∗∗*p*=.01 ∗∗∗*p* < .001

Chapter Seven: Discussion

The aim of the current study was to investigate the relationship between early literacy skills and later reading in Arabic (L1) and English (L2) for children in Grades 3 to 4 primary in the state of Kuwait and to determine whether basic literacy skills in Arabic and English develop in parallel. It also aimed at creating a model of Arabic literacy acquisition based on the data collected throughout the different times of the study.

In answer to the first and second research questions, i.e. identifying predictors and processes that underlie literacy acquisition of L1 and L2 in young students in Kuwait and determining which of these constructs can predict later literacy skills in Arabic and English in Grade 4, the chapter will discuss the results of the research in light of previous studies and findings. Both concurrent and longitudinal predictors of literacy are going to be discussed. In answer to the third and fourth research questions, i.e. investigating the concurrent development of basic literacy skills in English and Arabic to determine the extent to which literacy skills develop in parallel between the two languages. Differences and similarities between the two languages are going to be highlighted when discussing the English measures, and then cross-language transfer will be discussed to show the extent to which L1 can affect L2 or vice versa. In answer to the fifth, sixth and seventh research questions, i.e. investigating the applicability of the SVR to Arabic and English, and building a model of Arabic literacy based on the data, the discussion section on Arabic measures will be followed by a section discussing the SVR, and another one proposing a model based on the data. The section on English results will discuss how the SVR can be applied to English (L2) in the current study.

A. Arabic Reading Skills

Reading Accuracy and Fluency

Results show that both decoding and orthographic processing predicted Arabic word reading accuracy concurrently and longitudinally, with decoding being the strongest predictor (for similar results on decoding see: Al Mannai and Everatt, 2005; Christo and Davis, 2008; Netten, Droop and Verhoeven's, 2011; Smythe et al, 2008). Orthographic processing explained unique variance in word reading accuracy in

Times 1 and 3 after taking into account the variance explained by vocabulary and decoding (Abu-Rabia et al., 2003; Arab-Moghaddam and Senechal, 2001; Juel et al., 1986). Vocabulary predicted both word reading and non-word decoding in Grade 3 only; similar results were obtained by Mitchell and Brady, (2013), who argue that vocabulary facilitates decoding new words, or vowel patterns, and is important in cases in which the word cannot be easily decoded. They also argue that relying on lexical knowledge depends on the child's level of reading acquisition. Phonological processing predicted word reading accuracy concurrently and longitudinally, but its longitudinal predictive power extended to Time 2 of the study only, and then diminished in Time 3. Similar results were found on English by Hogan, Catts and Little (2005). They found that phonological awareness measures predicted word reading from kindergarten to second grade, in second-grade while they did not provide unique information to the prediction of fourth-grade word reading beyond that provided by second-grade measures of word reading and phonetic decoding. They argue that by second grade, the best predictor of word reading is word reading, and they propose using reading measures and phonological decoding measures as better assessment tools of reading outcomes. Phonological processing contributed significant variance in non-word decoding in both 1 and Time 4. Path analyses show that phonological awareness has an indirect longitudinal path to word reading via decoding in Time 3 (Yesil-Dagli, 2011). Morpho-syntactic skills contributed unique variance to word reading in Time 1.

Findings suggest that the children by Time 1 have reached a "Consolidated Alphabetic Phase", as proposed by Ehri (2002). For example, path analyses show that morphological segmentation predicts word reading via decoding, which suggests that children at this stage may have started to rely on morphemes to support the decoding of words. In Time 3, orthographic processing (mainly word chains) was the only variable that added unique variance in word reading over that explained by decoding. The path analyses show that word chain has paths to both word reading and decoding. Orthographic skills (namely word chains and orthographic discrimination) also showed direct relations to reading fluency at this point, in addition to phonological skills. This suggests that by time 3, children might be relying more on sight word reading, rather than decoding letter by letter and using grapheme-phoneme connections.

The Consolidated Alphabetic Phase of Ehri, however, does not explain word reading accuracy in Time 2 of the study, when vocabulary was the only variable that added unique variance in addition to that explained by decoding. The dual route model of Coltheart and the dual route cascaded model propose a better explanation of the difference between Time 1 and Time 2. In Time 1, regressions show that morpho-syntactic processing adds unique variance to that explained by decoding, phonological and orthographic skills. Path analyses also show that morphological segmentation and sound deletion both have paths to word reading via decoding. This suggests that the children are reading words at this point by mapping word's graphemes onto the orthographic unit that provides the best matches, and then using the orthographic unit to directly activate a phonological unit corresponding to that word's pronunciation (as explained by the dual route cascaded model). In Time 2, however, vocabulary is a predictor, in addition to word decoding. The presence of both variables, i.e. decoding and vocabulary, suggests that children are using both the direct route, which processes words as gestalt or wholes and allows the meaning to be accessed, for known words; and indirect route to read unknown words. Some studies on the Arabic language suggest the "word-superiority" effect, i.e. that words may access the lexicon “directly” by using whole-word orthographic codes, thereby permitting direct access to whole-word phonological information. Ibrahim (2013, a) for example found that among Arabic readers, pseudoword reading was the slowest and least accurate and that reading non-vowelised words was the fastest and the most accurate while reading vowelized word naming speed and accuracy was in between. Vocabulary, however, shows prediction power of both reading accuracy and fluency only in Time 2 of the study, it does not show any relations, either concurrently or longitudinally in other times of the study. In Time 3, orthographic processing is the only variable that adds unique variance in reading accuracy after taking into accountability the variance explained by decoding

The fact that path models show that vocabulary is not directly related to word reading in other times of the study is in line with results of studies on English, like Ricketts et al. (2007), who found that vocabulary did not predict text reading accuracy, non-word reading or regular word reading, and Muter et al. (2004), who found similar results on word reading accuracy for children in the first two years of learning. They are also in line with studies on Arabic, e.g. Abu Ahmad at al. (2014) who found that for Arabic children, main precursors of word recognition in fully vowelized Arabic are intra-lexical factors such as phonemic awareness, phonological processing, early literacy and morphological awareness, rather than higher-order extra-lexical factors such as semantics (namely receptive vocabulary), syntax, general cognitive abilities and working memory. They also found that the strongest individual predictor of word recognition in the study was phonemic awareness.

Unlike reading accuracy results, phonological skills were more predictive of reading fluency than were orthographic skills, since the latter predicted reading fluency concurrently but not longitudinally. Decoding did not add any variance beyond that explained by word reading (Khateb, Khateb-Abdelgani, Taha and Ibrahim, 2014). Phonological awareness was generally indirectly related to word reading accuracy via decoding while it had a direct effect on fluency in Time 1 (Ashby, Dix, Bontrager, Dey and Archer's, 2013; Solari et al., 2014), and RAN had direct relations to fluency at all times of the study. The relationship between RAN and fluency is expected since it is a speeded task (on Arabic see: Asaad and Eviatar, 2014; Farran, 2010; Saiegh-Haddad, 2005; Taybah and Haynes, 2011; Zadeh, Farnia and Geva, 2012; on English see: Christo and Davis, 2008; and on Italian see: Tobia and Marzocchi, 2014) but there is a general reliance on phonological skills until Grade 4, when students start to use non-vowelised textbooks (decoding was predicted by phonological awareness in Time 4). This shows that students still rely on phonological skills when learning or trying to read new strings of words and that the speed of processing is important for their reading fluency. In other words, the better the children are in decoding new letter strings, the more accurate their reading is, and the faster the children are in this process the more fluent they are as readers. The fact that this reliance still extends to Grade 4, might be due to that reading non-vowelised words requires decoding a certain word in more than possible way. For example, a word like "كتب" (to write), could be read in at least the following different ways: /kataba/ meaning wrote, /kutiba/ meaning written, /kutub/ meaning books, /kat'taba/ meaning to make someone write, or /kut'tiba/ was made (or asked) to write. Unless the child has a certain advanced morpho-syntactic level in Arabic that will enable them to guess a the correct pronunciation of the word without having to decode it letter by letter (recognise it), they will have to rely on decoding skills to decode it in all the previously mentioned ways and see which one fits best in context. Similarly, Elbeheri and Everatt, (2007) argue that, for Grade 4 and Grade 5 Arabic speaking children, the ability to apply phonological processing skills within novel reading situations may play an important role in the development of Arabic literacy skills, even after the move to the use of non-vowelised text in most learning contexts. RAN effect on accuracy, on the other hand, did not exceed Time 2 of the study, and it faded in Time 3. Syntactic awareness rather than morphological awareness was related to fluency, so while the children's morphological knowledge affects how accurate they read words, it was their syntactic knowledge that affected how fluent they are. Syntactic knowledge might be enabling them to guess some features of the words that will come next. For example, a subject in Arabic ends with the short vowel 'u', while an object ends with 'æ'. Therefore, having a sentence with a certain 'subject'' that did a certain 'action', might entail an 'object' which will naturally end with an 'æ' sound. With this syntactic knowledge, the child does not have to stop at each individual word and decode all the diacritics above and below it to pronounce it correctly, a process which consumes a lot of time. They can simply use this prior knowledge to guess certain words in the text, which enables them to be faster and more fluent readers.

Text Comprehension

Results show that early predictors of marked comprehension were mainly word-level (word reading/decoding and vocabulary). In Time 3 (i.e. Grade 4), comprehension predictors shift from simple word-level predictors to more complex text-level predictors (e.g. morpho-syntactic skills). This was also the case for comprehension fluency. These results are to some extent in line with Adlof et al. (2006) who suggest that children at early stages focus on word level reading skills and that later, when their decoding skills improve, language-related factors become more significant in comprehension. This is quite obvious in Time 3 when the effect of both word reading and decoding on marked comprehension have become indirect via morpho-syntactic skills. They are also consistent with Abu Ahmad, et al. (2014), who found that for young Arab children (KG and Grade 2), reading comprehension was explained by both intra-lexical (alphabetic, visual-orthographic and morphological) and supra-lexical measures (semantics, syntax, general cognitive abilities and working memory).

Though there is generally a shift from word-level to text-level, word-level skills still contribute to reading marked comprehension. For example, results show that both orthographic skills and morphological skills were related to marked comprehension. The complexity of the Arabic orthography suggests that a reader may have to rely on orthographic skills more than some other orthographies, particularly because of the use of diacritics. Similarly, the fusional (inflecting) nature of Arabic may require a reliance on morphological skills. This is consistent with previous studies on Arabic orthography (e.g. Abu-Rabia, 1999, 2007; Everatt et al., 2013; Ibrahim et al., 2002; Tahan et al., 2011).

Similar to marked comprehension, both word reading/decoding and vocabulary predicted unmarked comprehension; however, unlike marked comprehension, the early predictors of unmarked comprehension were both text-level (i.e. morpho-syntactic skills) and phonological predictors rather than orthographic like marked comprehension (Everatt et al, 2013; Layes, Lalonde and Rebaï, 2014). Early morpho-syntactic skills in addition to decoding and phonological skills (particularly RAN which is directly related to comprehension in Times 1 and 3, and in Time 3 they added significant variance over-and-above that explained by word reading and morpho-syntactic processing) predicted later comprehension. Time 1 syntactic awareness is directly related to comprehension. This result is in line with the arguments of Perfetti (1985) that syntactic context may help predict words when reading, and of Cain (2007) that syntactic skills support word recognition skills by assisting a reader to use the grammatical structure of a sentence to decode unfamiliar words.

The findings contradict the orthographic depth hypothesis (Katz and Frost, 1992), which claims that the use of assembled phonology should be more prevalent when reading a shallow orthography than when reading a deep orthography. In marked comprehension, orthographic processing rather than phonological came as a constant predictor of comprehension in all times of the study. Furthermore, the hypothesis claims that deep orthographies encourage a reader to process printed words by referring to their morphology via the printed word's visual-orthographic structure. In our study, morphological skills have direct paths to non-marked comprehension in both Time 1 and Time 3 of the study, and morpho-syntactic skills add unique variance in both times over-and-above that explained by word reading. For marked comprehension, it is not until Time 3 that the morpho-syntactic skills add unique variance in comprehension. As a matter of fact, it is exactly at this time that they have unmarked school books. All their textbooks at this point, except for Quran and Arabic language, have only the final diacritic marks that show the syntactic usage of the word (i.e. inflections) and the rest of the diacritics are eliminated.

Word Reading/Decoding and Arabic Reading Comprehension

In all comprehension measures in the present study, word reading had a direct effect on comprehension and decoding had an indirect effect on it via word reading (in addition to either vocabulary or morpho-syntactic skills depending on the comprehension measure and the time of the study). The results are in line with studies that showed the importance of decoding in comprehension for different cohorts, e.g. on English, Cutting and Scarborough (2006), on learning difficulties, Christo and Davis (2008), on languages other than English, Netten et al., (2011) found results on Dutch, both as a first and second language, and finally results from reviews of combined studies, like Garcia and Cain's (2014) meta-analysis of the combined results of 110 studies conducted with more than 42,000 readers. In the current study, the variance word reading added to reading comprehension after controlling for age decreased slightly between Grades 3 and 4. This is also in line with different studies on the SVR (see the review of Garcia and Cain, 2014). To see if this pattern continues, it is vital to conduct other studies of Arabic students that extend to higher grades to see if the contribution of word reading and decoding is going to decrease even more.

Vocabulary and Arabic Reading Comprehension

Results on all comprehension measures showed that vocabulary added unique variance to comprehension measures after controlling for age and word reading/decoding (with the exception of the Time 2 analyses when vocabulary failed to add any variance explained in comprehension fluency). This finding is line with studies that found that found a relationship between vocabulary and comprehension (e.g. Munger, LoFaro, Kawryga, Sovocool and Medina, 2014; Muter, at al., 2004; Ricketts et al., 2007; Tunmer and Chapman, 2012). The effect of vocabulary on comprehension shifts to be completely indirect in all comprehension measures in Grade 4, mainly via morpho-syntactic skills. This finding is in line with studies that found indirect effect of vocabulary on comprehension via other variables, like word reading, or listening comprehension (e.g. Cain, 2015; Protopapas, Mouzaki, Sideridis, Kotsolakou and Simos, 2013).

Indirect paths via syntactic awareness, suggest that vocabulary has a direct effect on syntactic awareness, and it has, in turn, an effect on comprehension. The types of Arabic vocabulary as discussed in Chapter three suggests that, unlike English, Arabic has three major types (nouns, verbs, and articles), each of which is divided into different types. The final diacritics of uninflected vocabulary never change according to their grammatical function: e.g. articles like the preposition (عَنْ) /ʕən/ meaning 'about', past forms of verbs like (قالَ) /qɑlə/ meaning 'said', or demonstratives like (ذَلِكَ) /ðælikə/ meaning 'that', (these examples were used in word reading measures of the study). The results then suggest that by memorising Arabic vocabulary, the children unconsciously improve their syntactic awareness. For example, when memorising a pattern that always ends in the short vowel /æ/, knowing that this is a past verb, like the previous example (قالَ), the child will then recognise the tense of a particular sentence (or context) in the future (i.e., past tense). Even after removing diacritics, a child may spontaneously read it the same way, providing that the child has reached a reasonable level of automaticity. What implies this level of automaticity is having RAN as a direct predictor of all comprehension measures in Time 3 of the study, in addition to having RAN, vocabulary and word reading as direct predictors of syntactic awareness at the same time. In other words, the child may have reached a degree of automaticity in word recognition, so they sight read a word, and at the same time recall both semantic and syntactic features related to it. These syntactic features, in turn, affect their understanding of context. (See also Guo, Roehrig and Williams, 2011, for slightly different direct and indirect effects in English.)

Morpho-Syntactic Skills and Arabic Reading Comprehension

The contribution of morpho-syntactic skills to reading comprehension changed across different times of the study. In Time 1, for example, morpho-syntactic skills did not add any unique variance over-and-above that explained by word reading in either marked comprehension or comprehension fluency, while it added unique variance in non-marked comprehension after controlling for age and word reading. In Time 3, however, its contribution to all reading comprehension measures increased. This change could be explained by the interactive-compensatory model which shows that relative reliance on context shown by skilled and less-skilled readers may change at different levels of the processing hierarchy. The results show that while fourth graders' comprehension in the present study was generally predicted by their early vocabulary knowledge in Grade 3 (except for non-marked reading in Time 1), their later morpho-syntactic knowledge at the beginning of grade 4 came as a better predictor in all comprehension tasks. Despite the fact that both non-marked comprehension and comprehension fluency measures did not have any diacritics, Time 1 morpho-syntactic skills predicted the former while vocabulary predicted the latter better. SEM models show that decoding had a direct path to non-marked comprehension while word reading had a direct path to comprehension fluency. In both tasks, the orthography was deep and definitely the children needed facilitators to comprehend words which could be decoded in more than one possible way (because of lack of diacritics). For the non-marked text obviously the children relied on context to extract meaning, since for all the texts "*the context was adequately understood"* (Stanovich, 1984)**,** while for the fluency task, which was basically a speeded sentence level comprehension task, vocabulary came as a better predictor. The children, however, seem to have developed the skills used to tackle comprehension fluency later, since morpho-syntactic skills came as predictors along with word-level skills by Time 3 of the study, with syntactic awareness having a direct path to comprehension fluency, though not as predominant as they were for marked and unmarked comprehension at the same time of the study. Obviously, the ability to fluently tolerate ambiguity in a text develops later than the ability to analysis a text and extract meaning.

Path models show that Time 1 morphological segmentation was directly related to marked comprehension, and that Time 3 morphological segmentation was directly related to both marked and non-marked reading comprehension tasks (similar results were obtained by Abu-Rabia et al., 2003; Mahfoudhi, Elbeheri, Al-Rashidi and Everatt, 2010, on Arabic; Deacon and Kirby, 2004, on English; Kieffer et al., 2013, on bilinguals; Pittas and Nunes, 2014, on Greek).

There are, however, different findings from some studies on Arabic. For example, Farran (2010) and Farran et al. (2012) found that neither Arabic phonological (elision and blending) nor Arabic morphological awareness skills contributed significantly to English-Arabic bilingual children's Arabic reading comprehension skills. Furthermore, after controlling for age, phonological processing and vocabulary, morphological awareness contributed only slight additional variance in Arabic reading comprehension. The divergence in studies' results might be due to the different tools used to measure morphological awareness. For example, Farran (2010) used morphological relatedness, i.e. presented a pair of words to the child, and then asked them if the word pair was morphologically related or not. The current study measures morphological awareness using a segmentation task, i.e. the child had to segment the morpheme from the root. Other reasons might be the degree of proficiency of Arabic, for example, in Mahfoudi et al. (2010) and the current study, Arabic is the native language (i.e. home language), and schooling language, while in Farran's (2010), the language of schooling was English and children's parents were native speakers of other languages like English, Urdu, Turkish, Tamil, or French., and children studied Arabic as a second language. The reason for these differences across studies of Arabic has yet to be determined but provides an argument for further data collection in the future. In current data, though, do argue for links between morpho-syntactic processing and reading comprehension in Arabic, but that these links may vary with reading experience.

Fluency/Speed of Processing and Arabic Reading Comprehension

A number of studies have investigated the possibility of adding a fluency component to the SVR (e.g. Johnston and Kirby, 2006; Joshi and Aaron, 2000). The results of the present study with Arabic-English children showed that RAN had mainly direct links to comprehension measures at Time 1 and Time 3 of the study (except for Time 1 marked comprehension when its effect was indirect via word reading). This result is consistent with studies on English: for example, Kirby et al. (2003) found that individual differences in naming speed prior to formal reading instruction were still moderately associated with reading success 5 years later, despite controlling for initial general mental ability, early achievement, and phonological awareness. Naming speed had significant effects on both word reading and comprehension.

Furthermore, the results of the current analyses indicated that (i) marked reading comprehension had significant moderate correlations with text reading fluency, (ii) non-marked reading comprehension had rather higher correlations than marked text, and (iii) comprehension fluency had high correlations with text reading fluency. Such correlations are in line with studies on transparent orthographies (e.g. Kim, Park and Wagner, 2014, on Korean; Veenendaal, Groen and Verhoeven, 2015, on Dutch). Since grapheme-phoneme correspondences are more consistent in transparent orthographies, speed of processing and fluency come as better predictors of reading than accuracy. Some studies like Seymour, Aro and Erskine (2003) found that while reading accuracy in transparent orthographies reached a ceiling effect by the end of Grade 1, in less transparent orthographies they are still lower, with English being amongst the lowest. It could be concluded then, that a fluency component could be added to the SVR when applied to the Arabic reading comprehension. It is noticed, however, that for non-marked comprehension and comprehension fluency, both RAN and text reading fluency had a more direct and larger effect than it had on marked comprehension. This finding is line with Layes et al. (2014) on partially vowelized Arabic. This might be expected for comprehension fluency since it is a speeded task. However, for non-marked comprehension, an alternative explanation may be that automatic sight word processing is important to facilitate the process of word recognition in the non-marked text, otherwise the child will decode a word in a number of different ways that might lead to confusion and additional processing to decide which possible pronunciation best suits the context. Joshi and Aaron (2000) argue that, sight word reading skill (or speed of processing) can be considered an accretion to decoding skill. In this study both Time 1 RAN and predict non-marked text comprehension, and Time 3 word reading and RAN predicted it. This could be because the children begin to master the skill of decoding and had reached some degree of automaticity by this level. In other words, they start recognising real words rather than decode them letter by letter, and this ability reflects on their understanding of the text. This relates to Joshi and Aaron's argument that during the first three grades of elementary school decoding is more closely associated with reading skill than speed of processing information, and that after this, speed emerges as an important factor, since children become able of reading many words by “sight” without relying entirely on to the relatively slow decoding process.

The Simple View of Reading and Arabic

The previous discussion of the study's results shows that the SVR can be applied to Arabic. As discussed above, measures of linguistic comprehension (vocabulary and morpho-syntactic skills), and word recognition/decoding are both able to predict Arabic reading comprehension. These results are consistent with the SVR (Gough and Tunmer, 1986; Hoover and Gough, 1990), and in line with many studies that tested the model across both alphabetic and non-alphabetic orthographies (Aaron et al., 1999; Florit and Cain, 2011; Joshi et al., 2012). They are also in line with studies that applied the SVR to relatively more shallow orthographies such as Persian (see: Sadeghi, Everatt, McNeill and Rezaei, 2014) and Dutch (see: Veenendaal et al., 2015). Moreover, they are in line with studies that provided evidence that the SVR could be applied to Arabic; for example, Everatt et al. (2013). The only difference between this study and the results reported by Everatt et al. (2013), is that in the previous study, phonological processing skills and orthographic awareness influenced reading levels via word identification/letter string decoding; with speeded naming times also predicting word-level variability, and orthographic knowledge showing relationships to reading comprehension from an early grade, independent of word decoding. In the present study, both RAN and orthographic processing are directly related to comprehension, independent of word decoding/recognition. These direct effects of both variables diverge to some extent from the SVR, since they affect comprehension both directly and indirectly. Orthographic processing predicted unique variance in comprehension above and beyond that explained by word reading/decoding and language measures (i.e. vocabulary and morpho-syntactic skills). Time 1 orthographic processing (which came mainly from orthographic discrimination) added unique variance in Arabic reading comprehension fluency after controlling for word reading/decoding and vocabulary. Time 2 word chain also added unique variance in marked comprehension after controlling for word reading/decoding and vocabulary. Time 3 orthographic processing added unique variance (mostly from word chain) in marked comprehension after controlling for word reading/decoding and morpho-syntactic skills. Path analyses show that all these variables were directly related to comprehension measures.

B- Arabic Writing Skills

Results show that decoding generally predicted word spelling and word spelling predicted text spelling. They also show that while vocabulary was more predictive of word spelling, morpho-syntactic skills were more predictive of text spelling. Furthermore, path models show that word chain was directly related to word spelling in Time 1 then became indirectly related to it in Time 3 (via decoding). In Time 1, both decoding and RAN were also directly related to word spelling (see: Al Mannai and John Everatt, 2005, on Arabic; Christo and Davis, 2008, on English). In addition, word reading highly correlated with spelling tasks in all times of the study (Mohamed et al., 2012). In Time 3, the variance decoding explains, after controlling for age, decreases. Morpho-syntactic skills emerge as direct predictors while word chain shifts to be an indirect predictor. This finding is line with Azzam (1993), who found that between Grades 3 and 6; children's spelling strategies appeared to shift to the use of orthographic skills. They are also in line studies that show morpho-syntactic skills are related to spelling (e.g. Arnbak and Elbro, 2000, on Danish; Ravid, 2001, on Hebrew; Taha, 2013, on Arabic).

Results also show that both decoding and spelling, and morpho-syntactic skills contributed significant variance in coherence. This finding is in line with studies that linked spelling and composition in children from kindergarten to primary stages reading different orthographies (e.g. Berninger, Abbott, Abbott, Graham and Richards, 2002; Connelly, Dockrell**,** Walter and Critten, 2012; Graham, Berninger, Abbott, Abbott and Whitaker, 1997; Green at al., 2003; Kim, Park and Park, 2015; Puranik and AlOtaiba, 2012).

The previous results show that the Simple View of Writing (Berninger, Vaughan et al., 2002) can be applied to Arabic writing. Spelling and morpho-syntactic skills were the only variables to explain variance in Arabic writing coherence at all times of the study. Vocabulary had indirect paths to coherence via syntactic awareness or word spelling/decoding at all times of the study. Results on word spelling showed that phonological decoding explained most of the variance and that phonological awareness was indirectly related to spelling via decoding. Orthographic processing was directly related to spelling at Time 1, then by Time 3, indirectly related via decoding. RAN was directly related to word spelling in all proposed models, suggesting that the children may have reached a certain level of automaticity in decoding, which is manifest in the shift from having orthographic skills as direct predictors to having them as indirect influences by Time 3, when they start relying more on morpho-syntactic skills as direct predictors of spelling. Obviously, this degree of automaticity in lower-level skills (i.e. spelling and decoding), in addition to syntactic skills, both contributed to their writing coherence. Therefore, it could be said, that the better children at this age are in spelling (and more automatic), and grammar, the more coherent their writing is.

C. A Proposed Model of Arabic Literacy

The previous discussion of results and display of literacy models, particularly the Simple View Model, show that predictors of word-level literacy (i.e. reading accuracy and fluency, and word and text spelling) were mainly decoding skills and, phonological skills and orthographic skills. Morpho-syntactic skills were sometimes directly related to word-level literacy. On the other hand, text-level literacy, similar to findings of many studies on the SVR, was predicted by measures of word reading/decoding, and language measures (i.e. vocabulary and morpho-syntactic awareness). The model, however diverged from the SVR, in that orthographic skills had a direct relation to literacy due to the nature of the Arabic language. Based on these findings, the following model is proposed in the current study (See Figure 7.1).

In this model, literacy is affected by two important factors: those related to the nature of the orthography and attributes of the Arabic language, and those related to the skills of the individual. The mechanism of reading at the word level is influenced by two factors. The first is related to the transparency of orthographic input, and the ability of the individual's visual memory to retain this input until a correspondent phonological representation is found (or in other words until this input is decoded). Once the visual input is transformed into a phonological representation, meaning of individual words is then extracted from the mental lexicon; a process affected by the speed of retrieval (i.e., lexical access). At text level, the individual uses morpho-syntactic skills, after basic decoding or recognition of words, to link individual units, and support the resolution of any ambiguity, in order to comprehend the text being read. Based on the results discussed earlier in this chapter, lexical access speed can directly affect the comprehension level, particularly when the text is unmarked, and orthographic skills can directly affect comprehension when the text is fully marked. Obviously, when the text is unmarked, children need automatic and fast decoding skills in order to recognise a word that could be read in more than one possible way in the absence of diacritics. With marked text, however, the richness of the orthographic input seems to demand better orthographic skills to deal with the text and fully comprehend it. Morpho-syntactic skills seem to affect literacy not only on the text level but word level as well. Vocabulary, on the other hand, seems to shift from having a direct effect in earlier grades, to having an indirect effect on literacy via word level (reading or writing).

When writing, the previous process is, somehow, reversed. The individual uses their background information (semantics, pragmatics, etc.), in addition to their morpho-syntactic skills to build a coherent text. The individual then retrieves the suitable vocabulary from their mental lexicon and transforms these lexical units into the corresponding phonological representations. To spell the words, these representations are encoded into an orthographic output.

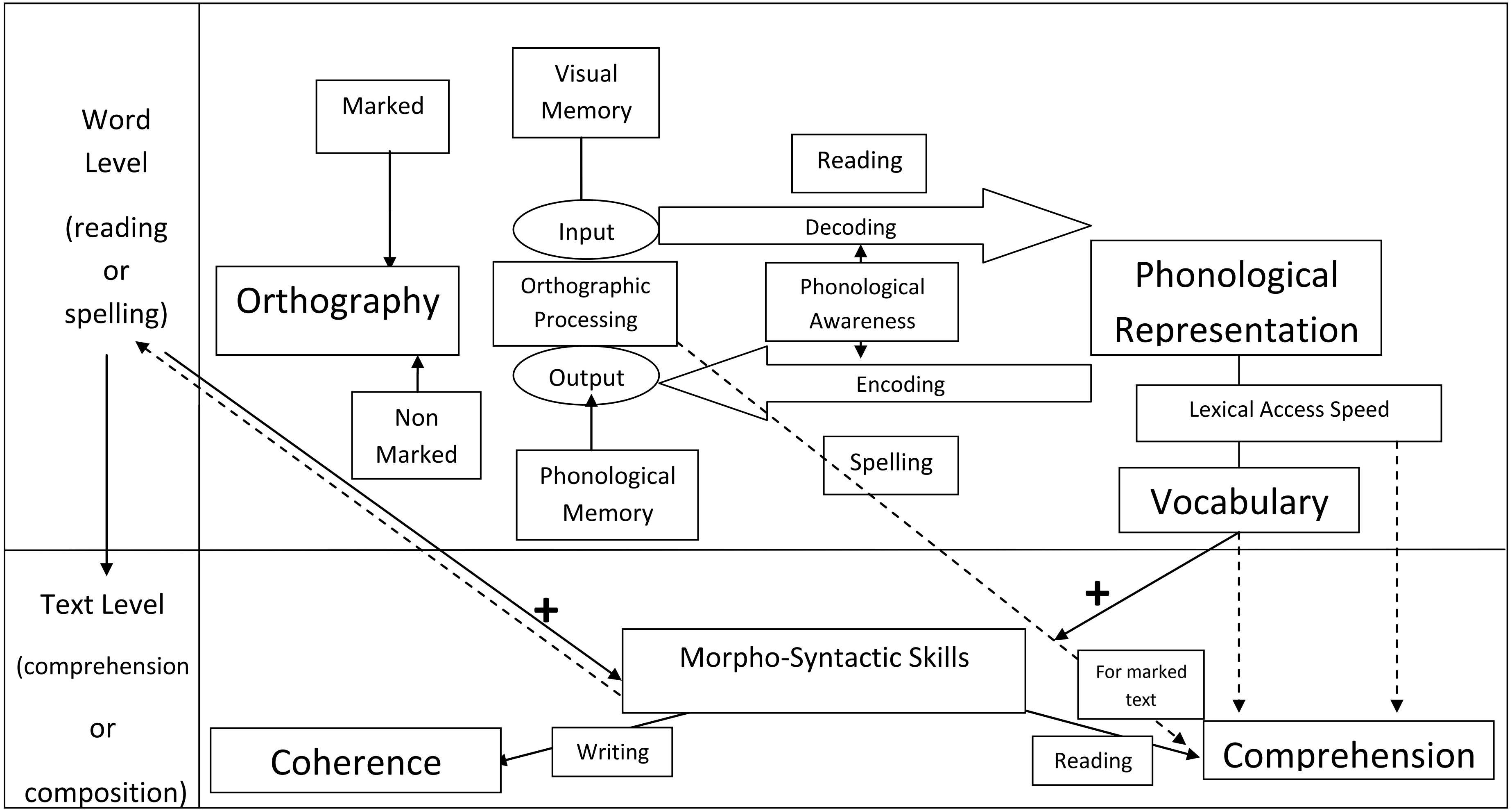
The model is to a great extent consistent with the SVR. The model shows that both word-level skills (i.e. word reading/decoding, and spelling), and text level skills (i.e. morpho-syntactic skills and vocabulary knowledge), predicted Arabic literacy (reading and writing). It diverges somewhat from the SVR in that orthographic skills also predicted comprehension independent of the two main constructs of the SVR (i.e. language and decoding). This would be most likely due to the nature of the Arabic orthography and its use of diacritics which requires more orthographic processing than in other orthographies such as English. Therefore, processing Arabic is not entirely bottom-up: although phonological and orthographic skills predict word-level literacy, which in turn predict text-level comprehension or composition, some of these word-level skills (i.e., orthographic processing and speeded processing) influence, and directly predict, text level skills. However, Arabic is not simply top-down either. Children do not simply approach the text with prior language and grammar knowledge and extract meaning from context. Processes are more interactive, with higher level skills (namely morpho-syntactic skills) influencing lower level literacy (i.e., word reading and spelling). Therefore, it could be said that this model is interactive in nature, and both word-level and text-level skills work simultaneously.

For fully marked text, for example, the early predictors of comprehension were word level skills, while later ones were text level. In other words, both vocabulary and word reading/decoding shift from being direct predictors of comprehension to having an indirect effect on comprehension via morpho-syntactic skills. This could imply that when a child approaches a certain text, they start decoding the orthographic input using their orthographic and phonological skills (i.e., lower level skills), then retrieve the meaning of words and build connections between these words using their grammar knowledge. With time, children develop automaticity in this process, in addition to the skill of using contextual features to help them read without having to stop and decode each individual word.

For unmarked text, on the other hand, the children seem to rely more on phonological rather than orthographic skills, in addition to text-level skills. The depth of the orthography compared to the marked one, makes approaching the text with prior knowledge, and using all contextual cues important to comprehend a text, which makes it appear to be rather top-down in nature. The need to decode certain homographs more than possible way makes phonological skills directly related to comprehending unmarked text. Therefore, unless the child approaches the text with prior satisfactory text-level skills that will enable them to derive meaning immediately from context using their vocabulary and morpho-syntactic knowledge; they will have to shift to word-level skills to decode a certain word in more than one possible way. They will then have to use their text-level (i.e. vocabulary and morpho-syntactic) skills to see if the word matches the context, then back to the word-level again to try another way of decoding it, and so on until they reach a satisfactory way to decode the word that suits the context. The faster this process is, the better comprehenders they are.

For writing, the model does not diverge from the Simple View of Writing, so both word level and text level seem to take place simultaneously, with children using their lexicon to choose words that represent the ideas they are trying to generate, and using their grammar skills to create a coherent text. With spelling as a direct predictor of coherence in all times of the study, the children seem to be using the words they know how to spell and refrain from unfamiliar or difficult words they cannot spell. The morpho-syntactic skills, however, affect their spelling, which makes it like comprehension, an interactive process, when both word-level and text-level skills work concurrently.

Figure 7.1 A Proposed Model of Arabic Literacy



D. English Reading Skills

Reading Accuracy and Fluency

Results show that decoding was the main predictor of English word reading and that vocabulary contributed significant variance in word reading. They also show that orthographic processing was the only variable to add unique variance in both reading accuracy and fluency in all times of the study after controlling for age, decoding and vocabulary. This suggests that the children might have reached an orthographic phase, as proposed by Frith (1986), and that by this stage, they can recognise morphemic parts of a word and split the word into its composing morpheme. Unlike results on Arabic, both orthographic and phonological processing added unique variance in English word reading accuracy after controlling for decoding in Time 3, while decoding explained most of the variance in Arabic word reading in all times of the study, after controlling for age. This shows that the development of English literacy as a second language is a bit more delayed than Arabic. In other words, while the children have developed the skill of reading words by sight in Arabic at this point of the study, they still rely on decoding and phonological skills to read English words. This might be due to the deep nature of English orthography versus the shallow nature of Arabic, particularly during the first three years of school. Furthermore, while children have RAN and syntactic awareness as general predictors of Arabic reading accuracy and fluency, they have morphological awareness and word reading or decoding as direct predictors of English reading accuracy and fluency. This suggests that the children have reached a certain degree of automaticity in Arabic they have not reached in English. This finding is consistent with studies that compared English as a deep orthography to other shallow orthographies (e.g. Seymour et al., 2003). Vocabulary was indirectly related to word reading accuracy at Time 1, and then became directly related to it in Time 3. Regressions also show that the variance explained by vocabulary increased for Grade 4 students than for Grade 3. This shows that by Time 3, children start utilising both the direct or "lexical route" and the indirect or "sublexical" route as proposed by the dual route model by Coltheart. This is also shown by word chain which has a direct route to word reading in Time 3 (see discussions in Khateb et al., 2014). In their research, they argue that word superiority affects reading for Grades 3, 6 and 9 children since children in all grades recognised the real words faster and more accurately than pseudowords and that grade affects their response time speed positively, suggesting a development of their visual lexicon.

Text Comprehension

Word Reading/Decoding and English Reading Comprehension

Results show that word reading/decoding predicted English reading comprehension. Similar to the results with Arabic, word reading/decoding explained almost half of the variance in reading comprehension. The amount of variance it explained was similar to Arabic non-marked comprehension results. Time 1 decoding was directly related to comprehension (similar to results on Arabic non-marked comprehension). However, similar to marked comprehension, neither Time 3 word reading nor decoding were directly related to English reading comprehension. These findings are in line with studies that found a relation between word reading/decoding and comprehension in various orthographies (e.g. Aaaron et al., 1999; 2008; Adlof et al., 2006; Christo and Davis, 2008; Florit and Cain, 2011; Netten et al., 2011). The results also show that the contribution of decoding in English comprehension decreased slightly in Grade 4 compared to Grade 3. In addition, decoding was the predominant predictor of comprehension in Time 1 (word reading was insignificant when entered after age and decoding), whereas, in Times 2 and 3, it became non-significant after controlling for age and word reading. This finding implies that the children are starting to acquire some degree of automaticity in decoding by this age. As suggested earlier in this chapter, the children might have transitioned into an orthographic phase by this time, but obviously they have not reached a full automaticity level when sight word reading is smooth enough and facilitates comprehension since RAN is not directly related to either word level reading or comprehension. The slight decrease of variance explained by word reading in Time 3 is line with studies that suggest that the influence of decoding decreases across grades (e.g. Cain, 2015).

Vocabulary and English Reading Comprehension

Results showed that vocabulary was moderately related to English reading comprehension at all times of the study. In Times 1 and 2, it did not add unique variance after controlling for age, word reading/ decoding, and morpho-syntactic skills and it was indirectly related to comprehension via decoding and morpho-syntactic skills. Similar results were obtained by Cain's 2015; Munger and Blachman, 2013. In Time 3, however, vocabulary did add variance and was both directly and indirectly related to comprehension. Similarly, Munger et al. (2014) found that vocabulary scores added significant variance in English reading comprehension beyond that explained by oral reading fluency scores for both third- and fifth-grade students. This is expected for English in the current study since English is a second language for children in Kuwait, and obviously, vocabulary did not start to contribute to comprehension, until children had built a lexicon that has a reasonable vocabulary size. The fact that vocabulary started to add variance in Time 3 is in line with Tunmer and Chapman (2012) who added a vocabulary component to the language construct of the SVR. It is also in line with studies that show that later vocabulary contributes more to comprehension than early vocabulary knowledge (e.g. Ouellette and Beers, 2010).

Morpho-Syntactic Skills and English Reading Comprehension

The results argue for morpho-syntactic skills to be moderately related to reading comprehension in English. Both Time 1 and Time 3 morpho-syntactic skills explained unique variance in comprehension even after controlling for word reading/decoding and vocabulary, and they both had a direct relation to comprehension. These results are more in line with those found with non-marked Arabic reading comprehension than with marked Arabic reading comprehension. They are also consistent with studies that found a link between English reading comprehension and morphological skills (e.g. Deacon and Kirby, 2004; Farran, 2010, on English-Arabic bilinguals; Kieffer et al., 2013; Wang, Ko and Choi, 2009, on Korean-English bilinguals). It is worth noting that in Time 1 of the study, morphological awareness had an indirect path to comprehension via decoding, while in Time 3 word reading had an indirect path to comprehension via morphological segmentation. It could be then that the relationship between awareness of morphology and progress in reading acquisition is reciprocal and mutually facilitative in that morphological awareness develops as a consequence of reading instruction (Verhoeven and Perfetti, 2003).

Syntactic awareness was a direct predictor of English reading comprehension from Time 1. Obviously, children needed all possible contextual cues (including morpho-syntactic skills in addition to later vocabulary), to extract meaning out of the text. These findings agree with arguments that syntax helps children predict or recognise words when reading (e.g. Cain, 2007; Perfetti, 1985; Proctor, Silverman, Harring and Montecillo, 2012).

Reading Fluency/Speed of Processing and English Reading Comprehension

In all times of the study, text reading fluency was highly correlated with English reading comprehension. This finding is in line with studies that showed that fluency affects comprehension, beyond decoding and linguistic comprehension (e.g. Silverman et al., 2013). This shows that fluency could be added to the SVR model in that it has an effect on comprehension. However, this finding contradicts studies that found a weak relationship between fluency and comprehension (e.g. Adlofet al., 2006). Unlike Arabic comprehension measures, RAN did not show direct relationships to comprehension in any time of the study. Its relation with English comprehension was moderate. This finding contradicts studies that found a link between speed of processing and reading comprehension for English monolingual children (e.g. Johnston and Kirby, 2006; Joshi and Aaron, 2000; Kirby et al., 2003; Messer and Dockrell, 2011). The fact that English is a second language for the Arabic children assessed in the current study might explain why RAN was not a direct predictor of their reading. At the time of testing, these children may not have reached a reasonable level of automaticity, which is also implied by having decoding explain most of the variance in word reading. Although, as suggested earlier, they are starting an orthographic phase, they obviously still rely on phoneme-grapheme mappings, and they have not completely exceeded this level yet. In other words, they have not reached a level of recognising words as units, and they still need to decode words letter by letter in order to be able to read them.

Phonological and Orthographic Skills and English Reading Comprehension

Regressions show that after controlling for age, word reading/decoding and language variables (vocabulary and morpho-syntactic skills); neither phonological nor orthographic skills added any unique variance in reading comprehension. These findings are in line with previous studies (e.g. Badian, 1995; Tong, Deacon and Cain, 2013). They are different from results on Arabic comprehension measures since phonological skills contributed to comprehension at different times of the study. Path models, however, show that English word chain was directly related to comprehension, particularly in Grade 4 (i.e. Times 3 and 4). These findings could be argued to be similar to the results obtained with Arabic marked comprehension, though the relationship between comprehension and word chain scores start earlier, in Time 2. By Grade 4, orthographic skills start to have a direct relation to comprehension, which might imply more dependence on orthographic skills at this age. The results of Grade 4 agree with the orthographic depth hypothesis (Katz and Frost, 1992), which argues that a reader processes printed words by referring to their visual-orthographic structure.

The SVR and English Reading Comprehension

As discussed above, word reading/decoding was a predictor of reading comprehension, and explained most of the variance in reading comprehension at all times of the study. Language skills (i.e. vocabulary and morpho-syntactic skills) both explained unique variance in comprehension at different times of the study, though in Time 1 morpho-syntactic skills explained more variance, and then later vocabulary started to explain variance in comprehension. These findings suggest that the SVR (Gough and Tunmer, 1986; Hoover and Gough, 1990) could be applied to English as a second language. They are also in line with studies that tried to apply the SVR to second languages (e.g. Gottardo and Mueller's, 2009, Lieder, Proctor, Silverman and Harring, 2013, on Spanish-English bilinguals; Sadeghi et al., 2014, on English-Persian bilinguals; Verhoeven and van Leeuwe, 2012, on Dutch-English bilinguals).

Morpho-syntactic skills came as a better predictor of later comprehension than vocabulary, which emerged in Time 3 of the study. This finding is in line with research in English-Arabic bilinguals (e.g. Farnia and Geva (2013). Generally speaking, in Grade 3 (Time 1 and Time 2), word decoding and reading both had direct paths to reading comprehension, then they both shifted to having indirect paths, or non-significant paths, to comprehension in Grade 4 (Time 3 and Time 4), a point when both language constructs (vocabulary and morpho-syntactic skills) had direct paths to reading comprehension. This finding is in line with some studies on the SVR (e.g. Vellutino, Tunmer, Jaccard and Chen, 2007). This shows the developmental shift to relying more on higher language skills as children grow up, rather than lower decoding skills. This transition is not notable in Arabic comprehension in the current study, particularly speaking for marked comprehension. This might be due to the fact that Arabic is the first language, and that the children might have gone through this type of transition earlier in their life when they first started to acquire their Arabic decoding skills. Another reason might be the nature of the Arabic language itself in its shallowest form, i.e. marked text, especially that this transition is somehow noticed in the non-marked text results (though children start using language skills from Time 1 for non-marked text).

E. English writing skills

Similar to the results for Arabic spelling, decoding explained a large amount of variance in English word and text spelling across all times of the study. They also showed that the variance explained by decoding was more than that explained by word spelling at almost all times of the study (the only exception was Time 3 when the variance was almost identical). These findings are in agreement with previous studies on English (e.g. Christo and Davis, 2008; Smythe et al., 2008). Unlike Arabic, vocabulary explained variance in word/text spelling beyond that explained by word decoding/spelling. Time 3 vocabulary had direct paths to both word spelling and text spelling. These results contradict other studies discussed earlier in Arabic spelling (e.g. Batnini and Uno, 2015; Kim, Apel and Al Otaiba, 2013; Li, McBride-Chang, Wong and Shu, 2012). However, they are in line with Kim, Al Otaiba, Puranik, Folsom and Gruelich (2014) who found a relationship between kindergarten children's vocabulary knowledge and spelling. Again, the children demonstrate abilities of younger children, showing that English literacy is a bit delayed than Arabic literacy.

Phonological skills predicted only word spelling in Time 3. This finding is line with results on Arabic spelling and some previous studies that found a link between spelling and phonological skills, (e.g. Arab-Moghaddam and Senechal, 2001; Cornwall, 1992; Elshikh, 2012; Smythe et al, 2008; and Wagner and Torgesen, 1987). Path models, however, show that none of the phonological skills was directly related to either word or text spelling in any time of the study (except for Time 3 RAN, which was directly related to text spelling), even in Time 4 when the only measures applied were phonological and orthographic. It could be concluded here that phonological skills were a better predictor of Arabic spelling than they were of English spelling. This may be explained if we consider Arabic as a shallower orthography than English. Phoneme-grapheme mappings in Arabic are more straightforward and easier than they are in English. This is why phonological skills are more important for Arabic, whereas in English orthographic skills are more prevalent. However, this interpretation will require further research as other studies seem to contradict this conclusion. For example, Georgiou, Torppa, Manolitsis, Lyytinen, and Parrila (2012) found that phonological awareness was related to English spelling, but not to spelling in Greek or Finnish, which are shallower orthographies; while RAN correlated with spelling in all three languages.

In contrast to the results found in Arabic, orthographic processing predicted English word spelling across all times of the study, and the level of prediction provided by the orthographic processing measures was greater than that provided by the phonological processing. Such orthographic measures were also more related to word spelling than they were to text spelling. This finding is somewhat consistent with some studies on English as a second language (e.g. Arab-Moghaddam and Senechal, 2001, on Persian-English bilingual children). This might be due to the nature of the English language as a deep or 'outlier' orthography versus Arabic which has a more consistent grapheme-phoneme mapping (see: Share, 2008). Similarly, syntactic awareness was both directly and indirectly (via decoding) related to word spelling in English, and both morphological and syntactic awareness were related to text spelling. This finding is in line with some studies on English (e.g. Bryant, Nunes and Bindman, 2000; Leong, 2000).

Results showed that decoding contributed significant variance to composition coherence after controlling for age. This finding is in line with the Arabic results as well as other studies of English (e.g., Abbot and Berninger, 1993). It is worth noting here that the variance explained by decoding in English composition is more than that explained in Arabic (almost half of the variance), and that English decoding was directly related to English coherence in Grade 3. This could be due to the fact that

English is a second language and the students have not reached the same degree of proficiency as they have in Arabic (L1). Results also showed that spelling predicted English coherence (like Arabic results), and was directly related to it at all times of the study. This finding is in line with studies that found a link between spelling and composition (Berninger, Abbot et al., 2002; Berninger, Vaughan et al, 2002; Connelly at al., 2012; Graham et al., 1997; Puranik and AlOtaiba, 2012). Unlike Arabic coherence results, English vocabulary contributed significant variance to English coherence after controlling for age and word spelling/decoding at all times of the study. This finding is consistent with studies that found a link between vocabulary and composition (e.g. on English: Dunsmuir and Blatchford, 2004; Nagy, Berninger, Abbott, Vaughan and Vermeulen, 2003; Silverman at al., 2015; on Dutch: Drijbooms Groen and Verhoeven, 2015). Morpho-syntactic processing added unique variance beyond that explained by word spelling/decoding and vocabulary across all phases of the study. The variance it added after controlling for age and word spelling/decoding was more than that explained by vocabulary. Path models show that syntactic awareness was directly related to coherence at all times. This finding is line with Drijbooms, Groen and Verhoeven, 2015, in their research on Dutch.

The previous results showed that word-level measures (i.e. word spelling and decoding) and language measures (i.e. vocabulary and morpho-syntactic skills) accounted for almost all the variance in English composition coherence (for similar results see: Babayiğit, 2014). The only exception was Time 3 orthographic processing which added significant variance beyond that explained by the aforementioned variables. Results also showed that word spelling/decoding and vocabulary were directly related to coherence at all times of the study. In contrast to the Arabic results, orthographic and phonological skills were related to English composition. Time 1 RAN, for example, has a direct path to composition coherence, and both Time 3 and 4 word chain scores showed direct paths to coherence. Similar results on English-speaking children were obtained by Hooper et al. (2011), and on children speaking European Portuguese (a language more transparent in reading than it is in writing), were obtained by Albuquerque (2012). Obviously, the children in the current study are still a bit behind in English proficiency than they are in Arabic, which may be why processing speed, along with orthographic skills, are still important for them when writing. Possibly they have not achieved the same level of automaticity in their basic writing skills (e.g., spelling) that enables them to focus on the content, rather than the process of encoding this content into an orthographic form. This is possibly why by both Grades 3 and 4; the students' Arabic composition is based mainly on their language skills (morpho-syntactic skills) and their basic literacy skills (i.e., spelling). In English, on the other hand, in addition to these two skills, the students seem to be relying on other cognitive skills (i.e., RAN and orthographic skills), since they have not achieved the same level of proficiency in the former skills as they have in Arabic (L1). One of the things that support this argument is that vocabulary is generally indirectly related to Arabic coherence via syntactic awareness, while in English it is directly related to coherence at all times of the study. The children might have reached a higher level of proficiency in Arabic when the semantic relationship between different words affects the way they arrange them syntactically to form a coherent text. In other words, not only do the children know the meanings of words, but this knowledge affects their syntactic structure of their written texts. In English, the children seem to be a step behind, when their knowledge of the meanings of words, (and how fast they can recall them), is still important for writing a coherent text.

F. Cross-Language Transfer

Results showed that, across all times of the study, all Arabic measures correlated with English counterparts, except for the vocabulary measures which did not correlate. The highest measures to correlate were the Arabic and English phonological awareness measures, and reading measures (decoding, word reading, and text reading fluency), followed by spelling. These results suggested that phonological awareness has the potential to transfer between first and second language. They were in line with cross-language transfer studies which show that phonological awareness skills of first language could predict literacy skills of a second language and vice versa (e.g. Abu-Rabia et al., 2013; Allaith and Joshi, 2011; Elshikh, 2012; Farran, 2010; Farran et al., 2012; Saiegh-Haddad and Geva, 2008; Tahan et al., 2011).

English word reading was moderately correlated with Arabic phonological awareness and word decoding. English word decoding was highly correlated with Arabic phonological awareness and word decoding. This finding could suggest a transfer of phonological skills from Arabic to English. It is in line with studies that showed a connection between first language phonological skills and second language reading skills (e.g. Alshaboul et al., 2014; Bialystok, Luke and McBride-Chang, 2005; Comeau, Cormier, Grandmaison and Lacroix, 1999; Durgunoglu et al., 1993; Gottardo, Yan, Siegel and Wade-Wooley, 2001; Sun-Alperin and Wang, 2011).

Literacy measures (i.e. reading and spelling tasks) highly correlated in both languages. This finding is similar to the findings of Abu-Rabia and Siegel (2002) on English-Arabic bilingual children. Morpho-syntactic and phonological skills were correlated with literacy measures across languages at each point in the study, suggesting the operation of similar processes in both languages. These findings argue for an interdependence of development across the two languages. Cognitive skills in the first language (i.e., Arabic) might have a transfer effect on literacy skills in English. The orthography of Arabic is different from English, yet results show that word chain was correlated with literacy measures across languages, and although Time 1 orthographic discrimination tasks had only weak correlations with literacy measure across languages, the relationship between orthographic measures and literacy measures across languages generally increased with grade level so that by Time 3, both word chain and orthographic discrimination had stronger correlations with literacy measures. Such commonalities in development are more suggestive of interdependence than orthographic independence.

H. Practical Implications

Teaching Methods

The results discussed above seem to suggest that the SVR could be applied to both Arabic (L1) and English (L2). Therefore, improvements in children's literacy development may be considered from the two core components of this model: i.e., improving decoding skills and improving comprehension skills. Since the results showed that decoding was prominent for comprehension and writing skills both concurrently and longitudinally, improvements in decoding skills might be a focus of better teaching. The aim of improving decoding is to increase students’ automaticity in phonic decoding and word recognition over time. Decoding could be improved by the use of context-independent, phonologically based decoding instruction to remediate word-reading deficits and encourage the use of smaller orthographic units to promote an understanding of the relationship between graphemes and phonemes. This may be particularly useful for teaching Arabic since phoneme-grapheme correspondences are more direct than for English (particularly when the marked version of Arabic is used). Furthermore, phonological processing showed a reasonable influence on decoding, which in turn affected word level reading. Therefore, early phonological training should positively influence the development word reading. Hulme and Snowling (2012) suggest training children in phonemic awareness, coupled with appropriate phonically based reading. Focused, evidence-based tutoring, as well as early intervention programmes (e.g. Orton-Gillingham) in the early stages of learning, can limit problems with reading and lessen the number of students who suffer from literacy problems (Vellutino and Scanlon, 2002; Vellutino, Scanlon and Tanzman, 1998). Decoding can be taught explicitly and systematically through demonstrating the relationships between letters and sounds and assisting children to recognise patterns rather rule memorising. Encouraging active and constructive exploration can promote decoding skills instruction and improve word reading skills (Elshik, 2013). In addition to one-to-one tutoring, classroom instructional process approaches especially cooperative learning and structured phonetic models, have proved to be effective for low achievers, as well as other students (Slavin, Lake, Davis and Madden, 2011).

To improve comprehension, we should aim to increase vocabulary (particularly for English as a second language) and syntactical knowledge and to teach effective strategies for extracting meaning from text. Compton, Miller, Elleman and Steacy (2014) suggest explicit instruction in sub-word orthographic–phonological connections along with exposure to training words that represent co-occurrences and constraints that exist between orthographic and phonological units. They also suggest that the learning of appropriate items within a language allows for the formation of long-term word specific representations as well as context-dependent sub-word orthographic–phonological connections. Students can practice dividing written words into onsets and rimes and practice the strategy of reading words by analogy. They should help make transitions from analogizing with prompts to analogizing consciously on their own, and then to analogizing unconsciously on their own (Ehri and McCormick, 1998). Techniques to enhance visual-verbal paired-associate learning may also be useful (Hulme, Monk and Ives, 1987), particularly in orthographies where orthographic processing has been found to be highly influential.

Assessment

Assessment should be targeted at certain skills that are related to literacy. As with the development of appropriate teaching methods, the assessment may need to consider early literacy skills, as well as early cognitive skills. The assessment of literacy skills should be targeted at identifying students' weaknesses in literacy areas; such as their decoding, reading and spelling skills. Identification of weaknesses should enable the assessor to create suitable intervention plans. Assessment of cognitive skills should comprise both language skills assessments (i.e., vocabulary, syntactic knowledge and morphological skills) and orthographic and phonological skills. These assessments could include: checking phonic knowledge and skills (e.g. letter-to-sound correspondences), checking phonological subskills (e.g. phonological awareness), checking sight vocabulary (e.g. using lists of commonly occurring words), checking comprehension, and checking fluency. Writing assessment could include: checking handwriting, checking spelling skills and strategies, and checking writing strategies (Westwood, 2009). Since morpho-syntactic skills showed significant prediction power of literacy skills, particularly in Grade 4, they could be used then as a clinical marker of later reading comprehension proficiency or difficulties. Further research along these lines, therefore, would be valuable.

Regular teacher assessments of children should also be considered. They should be embedded in school's policies so that they enable us to identify children with literacy problems as early as possible (Snowling and Hulme, 2012). In addition, since early vocabulary knowledge is directly related to literacy, teachers should use lists of common words to both assess and enrich students vocabulary during the early grades of schools (i.e., for Arabic language see Oweini and Hazoury, 2010).

The aim of an assessment should be to identify literacy problems as early as possible in order to build suitable remedial plans, and to screen individuals with learning difficulties or developmental learning disabilities (such as dyslexia) in order to use suitable intervention plans for those individuals. Results show that Grade 3 and 4 are critical for Arabic-English bilingual children. Therefore, it is recommended that assessment of underlying factor of literacy take place before these grades, in order to address children's problems as early as possible, so that by the time children reach these grades, they will have acceptable level of automaticity in both languages that will make transition into higher orthographic phases smoother and faster, particularly when children need to rely on unmarked textbooks in Arabic.

There is also a scarcity in assessment tools for Arabic compared to English. The researcher had to build some of the tools and pilot them repeatedly since there are not enough testing measures in Arabic, other than those provided by Centre for Childhood Evaluation and Teaching in Kuwait. The vocabulary measure is an example of a tool that had to be modified. This research shows the importance of building such tools since it showed how certain skills can predict later literacy. For example, early vocabulary knowledge seemed to affect later literacy directly, while later vocabulary knowledge affected it indirectly via morpho-syntactic skills. It is, therefore, vital to have standardized vocabulary measures that match different ages, particularly targeted at the primary stage. There is a need for Arabic testing batteries for all skills tested in this research, preferably one that can extend to higher grades and include middle school children.

I. Limitations

The generalizability of the results of this study is constrained by the following factors:

1. First, the sample is rather small and not optimally representative of Arabic-English bilingual children in the population. Additional research with larger and more diverse populations of Arabic-English bilingual children is needed. The current thesis has attempted to show how the findings are related to those in the literature, particularly research on Arabic, and hence provide evidence for the potential application of the findings; however, further work is still needed.

2. The data were taken from a boys' school only. Therefore, similar studies need to be conducted with girls to ensure that the findings are consistent across the two groups. It is, for example, possible that boys or girls in Arabic classes

learn to read and write at different rates, which may make the findings applicable at different points in the development of reading for the two groups.

3. Measures of the current study were applied to children in Grades 3 to 4. Again, further research across additional grades is needed to ensure that the results apply to literacy skills of children in Grades 5 and beyond when students are reading completely non-vowelized texts of increasing morphological and syntactic complexity.

4. The study was conducted on children from a predominantly middle-class background in the State of Kuwait. Again, generalizing the results to other Arab countries must be done with caution, and after controlling for background factors such as socioeconomic status. Further research across different Arabic learning contexts and countries will determine how representative of Arabic learning, in general, these findings are.

5. The effect of fluency on literacy measures was only tested via correlational effects, i.e. correlation coefficients. Further studies that investigate if fluency can predict literacy are needed (e.g. regression and path models), particularly those that measure the unique variance fluency can add in literacy after controlling for other factors like basic decoding skills, vocabulary, and morpho-syntactic skills.

6. The results of this study apply only to children with typically developing literacy skills. Children with a learning disability, those considered slow learners, and children suffering from any psychological problem (e.g., autism), were screened out from the cohort. Therefore, further research with different groups of learners will need to be conducted to apply the findings across those with differing learning weaknesses.

7. Reliability of measures in the current study ranged from those that showed high internal cosnsitncy coefeicients (e.g. Arabic sound deletion, Arabic text reading fluency and English text spelling), and other showing marginal internal cosnsitncy coefeicients (e.g. English non-word repetition and visual memory). Results of measures with lower reliability evidence need to be

extended to with caution. Results of composition coherence also need to be ganaralised with caution, since measures with more relaiability evidence are needed. Further research with similar methods that show more evidence of reliability is needed before ganarlising the results.

As discussed previously, most of the Arabic measures used in the study were developed by the researcher, based on current knowledge and best practice at the time. Further work with more standardized measures would be useful to support the findings presented in this thesis. It may be that other measures of literacy would show differing results and may go some way to explain some of the ambiguous findings reported in the literature. The current developed model of Arabic literacy might require further refinement to better inform theory and practice.

J. Possibilities for Future Research

There is generally paucity in longitudinal studies on the Arabic language. Further longitudinal research is needed on different age sectors, preferably on larger cohorts from different social backgrounds, and including both boys and girls. The effect of fluency on literacy, particularly on Arabic literacy, needs to be studied further. It is also suggested to apply different statistical methods like latent variables studies, factor analyses, and growth models, since studies that use these methods to analyses data in studies on the Arabic language are rare. Latent variable studies are going to minimize effects of errors and enable us to use more than one observed variable to measure a certain latent construct, e.g. using sound deletion, rhyming, blending, and segmentation to measure phonological awareness, or using isolated real words, pseudo-words and reading texts to measure decoding skills. Confirmatory factor analyses will ensure that the pattern of loadings among the indicators correspond with the latent variables being measured in the model. Finally, the structural model measures the influence of each factor in the structural model in latent regressions among the constructs. This intricate sequential process, leaves less room for errors, and ensures that the factors used in the model are representing of the constructs intended to be measured. Growth models can enable us to investigate growth trajectories over time. Vocabulary was measured in the current study using receptive vocabulary measures, therefore, it is suggested to measure the effect of both receptive and expressive vocabulary in future research (Batnini and Uno, 2015; Rose and Rouhani, 2012). The only memory measures used in this study were the phonological memory and visual memory tests, so the role of working memory in Arabic literacy, (particularly in writing), needs to be studied. The study of working memory enables us to extend our knowledge beyond the domain-specific storage systems of the phonological loop and the visuospatial sketchpad, and understand the central executive, responsible for retrieval of information from long-term memory, regulation of information within working memory, attentional control of both encoding and retrieval strategies, and task shifting, all of which are important processes when reading or writing. It is also suggested that future research on Arabic subdivide literacy groups into poor, average and good categories to enable comparisons in order to investigate the difference between such groups concerning the underlying skills that predict literacy best for each group.

The present study was applied to Arabic-English bilingual in a mainstream school in Kuwait, where Arabic is taught as a first language and English is taught as a second language. Applying similar studies to other samples would be useful: for examples, including children from language schools where English teaching is more intensified, and most of the texts books are in English (i.e., English is the language of teaching at school while the official language of the state and home language is Arabic). Studies of Arabic children who are less exposed to English than those in the present study would also be useful. This range of different language samples would provide a clearer understanding of the cross-language influences identified in the current thesis.

A major feature of learning the read and write in Arabic is diglossia. To address this issue and see how much it affects Arabic literacy acquisition, studies such as the one described in this thesis should be replicated with measures that use vernaculars of the local community. Most studies that investigated diglossia have been conducted on children in societies that have specific social conflicts and on one vernacular only (e.g. Saiegh-Haddad, 2003). Therefore, it is vital to conduct studies on various vernaculars across the Arab world, and on children from different socio-economic backgrounds, in order to see how much it affects literacy acquisition.

G. Conclusion

The aim of this study was to investigate literacy skills for Arabic-English bilingual children. Literacy skills were investigated for Grade 3 and Grade 4 children in the State of Kuwait. Measures of decoding, vocabulary, phonological skills, orthographic skills, and morpho-syntactic skills were applied to see how much they predicted literacy in both Arabic and English. The measures were applied at 6-month intervals through Grades 3 and 4. Data were analysed both concurrently and longitudinally to see how the previous skills affected the children's word-level and text-level reading and writing skills. The research results showed that decoding was generally the main predictor of word level reading, but it did not predict the shallower forms of reading comprehension, namely fully vowelized Arabic comprehension, and path models show that it was indirectly related to it via word reading. However, it explained unique variance in deeper forms of comprehension, i.e. non-vowelised Arabic comprehension and English comprehension. In writing, decoding predicted spelling in both Arabic and English, explaining more variance in English than Arabic spelling. Similarly, it explained more variance in English composition than it did in Arabic. Vocabulary explained small but significant variance in both Arabic and English word reading, beyond the variance explained by decoding. It also explained small but significant variance in almost all comprehension measures in Arabic and English in all times of the study. It generally did not add any variance in composition, beyond word spelling. Phonological and orthographic skills generally predicted word-level literacy in both languages, with orthographic skills diverging and have direct relations to text-level comprehension in Arabic; namely marked-text comprehension. Text level literacy was predicted by word reading/decoding or spelling, vocabulary and language measures in both languages. Results also showed that students were generally a step forward in Arabic literacy than they were in English. Decoding was more predictive of English literacy while word reading/spelling was more predictive of Arabic literacy. Vocabulary did not start to be a distinctive predictor of English literacy until Grade 4 (unlike Arabic).

The SVR was applied to both Arabic and English in the present study. Results show that the SVR in Arabic diverged a little from the original model, with RAN and orthographic processing being directly related to comprehension, independent of word decoding/recognition. The proposed literacy model, explains predictors of reading and writing on both word level and text level. The model shows how decoding/encoding is basically the main predictor on word level and how orthographic versus phonological skills work simultaneously when deciphering a written input, and the reversed process when writing. The model also shows that both morpho-syntactic skills are predictive of both word and text level literacy. Vocabulary is mainly an indirect predictor of literacy via mainly morpho-syntactic skills, or having a direct effect (in the case of marked reading).

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Appendices

Appendix 1: Consent Forms
Consent Form Child – (Arabic)

Email: shima_mahmoud@hotmail.com

نموذج موافقة للطالب

لقد أخبرتني معلمتي بخصوص المشروع.
يسعدني مساعدتك لي في القراءة و الهجاء في اللغتين العربية و الإنجليزية, أنا أعرف أن المعلومات التي تجمع عني لن يتم اخبارها لأي شخص آخر و سيتم حفظها في خزانة مغلقة, و أنا أعرف أنك لن تستخدمي اسمي أو اسم مدرستي في المشروع, و أن كل المعلومات سوف يتم اتلافها بعد كتابة المشروع, سيتسلم كلا من أبي أو أمي تقريرا موجز عن أدائي (لو أرادوا ذلك). و أنا أعرف أنني يمكن أن أغير رأيي حول الاشتراك في المشروع و لن يعترض أحد على ذلك, و أعرف أنه لو كان عندي أية أسئلة أو شكوى أو أردت الانسحاب من المشروع يمكنني أن أخبر مديرة المدرسة أو أتصل على:

1. دكتور جاد البحيري, مركز تقويم و تعليم الطفل, تلفون: 25353681
2. الاستاذ الدكتور جون افرات, مركز تقويم و تعليم الطفل, تلفون: 25353681

اسم الطالب:...
توقيع الطالب (أو ولي الأمر نيابة عنه):..................................
التاريخ:..

University of Canterbury Private Bag 4800, Christchurch 8140, New Zealand. **www.canterbury.ac.nz**

Consent Form for Principal (Arabic)
Email: shima_mahmoud@hotmail.com

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

نموذج موافقة لمديرة المدرسة

أنا سعيدة بعملك مع طلابي في الصف الثالث الابتدائي في مهارات القراءة و الكتابة و المهارات اللغوية في اللغتين العربية و الانجليزية, أعلم أن كل المعلومات التي سيتم جمعها لن يتم اخبراها لأي أحد آخر و سوف يتم حفظها في خزانة مغلقة, و أعلم أنك لن تستخدمي اسم المدرسة في المشروع أو اسم الطلاب أو المعلمات أو اسمي الشخصي, وأن كل المعلومات سوف اتلافها يتم فور الانتهاء من كتابة البحث, كما يمكن لولي الأمر تسلم تقرير موجز عن اداء ابنه (إذا أراد ذلك).

كما أني أعرف أنه يمكن لأي طالب تغيير رأيه في المشاركة في المشروع و لن يعترض أحد على ذلك, و أعرف أنه في حالة لو كان لدي, *أو لدى أي طالب*, سؤال, يمكنني أن الاتصال بك مباشرة, و في حالة وجود مشكلة أو شكوى يمكن للطالب اللجوء إلي أ/و يمكننا الاتصال بالجامعة أو الاتصال ب:

1. دكتور جاد البحيري, مركز تقويم و تعليم الطفل, تلفون 5353681
2. الاستاذ الدكتور جون ايفرات, مركز تقويم و تعليم الطفل, تلفون 5353681

الاسم:..
التوقيع:..
التاريخ:..

Ministry Of Education Permission

57/30/EA0092455/10/25000

٢٤١١

وزارة التربية
الإدارة العامة لمنطقة حولي التعليمية
مكتب المدير العام

رقم : ٢٦٤٩
التاريخ : ٢٢/٢/٢٠١٢م

نشرة عامة رقم (٣٧ / ٢٠١٢)

لجميـــع مدارس المرحلة الابتدائية

السادة والسيدات المحترمين / مديري ومديرات المدارس

تحية طيبة وبعد ،،،

الموضوع

تسهيل مهمة الطالبة / شيماء محمود محمد عبدالصبور

يرجى تسهيل مهمة الطالبة / **شيماء محمود محمد عبدالصبور**

المسجلة في جامعة كانتري في نيوزلندا بإعداد أطروحة الدكتوراه ، وذلك بإجراء دراسة تحت عنـــوان " أثر المهارات اللغوية الأساسية على تعلم القراءة والكتابة " وذلك بتطبيق أداة الدراسة (استبانه) ، على عينة من الطلبة والطالبات المرحلة الابتدائية خلال الفصل الدراسي الحالي ٢٠١١/٢٠١٢ م .

مع خالص التحية ،،،

مدير عام منطقة حولي التعليمية

٢١/٢/٢٠١٢م

منى خالد الصلال

<u>نسخة لكل من :</u>

- الوكيل المساعد للتعليم العام .
- مدير الشئون التعليمية .
- مراقبة التعليم الابتدائي .
- جميع مدارس المرحلة الابتدائية.
- الملف.
- * ط.باسمه حسين *

وزارة التربية
منطقة حولي التعليمية

Appendix 2: Non-word reading tasks

Arabic Non- word reading (Form B) for Time 4:

أَخْنَصْ – انْفَغَرَ – بَقْطْ – اِنْشَحَلْ – مُرْخِشْ – اَشْقِضْ – مُنْبَقِطْ – مَوْقَثْ – يَتَهافَران – بَصَعَ – غَشَدَ – جِمَطٍ – واجِقٌ – فَلْحَطٌ – أَطْلَشٌ – اِنْفَرْكَحْن – ماقِظٌ – نواغيسْ – مَضارِشٌ – تَباحَطْن – مَواكيخٌ – اِسْتِحْفاطْ – اِنْبِهاطاتٌ – اِسْتَظْخَشَ – مَهْكَشٍّ

English Non-word reading (Task 1)

Drill: (frosk – sheank – splan – frimp)

Test Items:

dat – dar – pim – zet – lunt – tash – vatch – hod – miction – moop – sead – howt – bupper – garken – thumpster – bling – pute – charb – chenwits – prejend – fraces – catavap – clate – plavel – hirth

English Non-word reading (Task 2)

Shol – Tam – Jint – Blim – Swad – Gruss – Chove – skoosh – tropment – plention - sabotack – rebably – ront – ving – fitosal – blash - Pule - zalotipik – catashin – misprelture – grames – gagy – stread – kariphanik - hirm

Appendix 3: Vocabulary Measures

Key answers to the Arabic Vocabulary Test - pilot 1

	Item	key	
a	ساعة	1	
b	شجرة	2	
c	يهاتف	2	
d	أذن	2	
1	كروي	3	
2	تمساح	4	
3	يسلم	1	
4	دائري	2	
5	إسعاف	3	
6	بطريق	1	
7	يسحب	4	
8	سهم	2	
9	بطيء	4	
10	أسطواني	2	
11	مفترس	1	
12	ظرف	2	
13	ميزان	4	
14	يهدم	4	
15	فنجان	4	
16	شلال	3	
17	مرعوب	1	
18	سداسي	1	
19	زاحف	3	
20	تنقيط	1	
21	يودع	3	
22	يقطر	1	
23	جزيرة	4	
24	غصن	3	
25	زاوية	2	
26	جارح	3	
27	يفرم	2	
28	خماسي	4	
29	مغارة	4	
30	يملأ	3	
31	منقوش	3	
32	يعتدي	1	
33	يتلصص	1	
34	متدفق	2	
35	يقذف	1	

Key answers to the Arabic Vocabulary Test (after piloting)

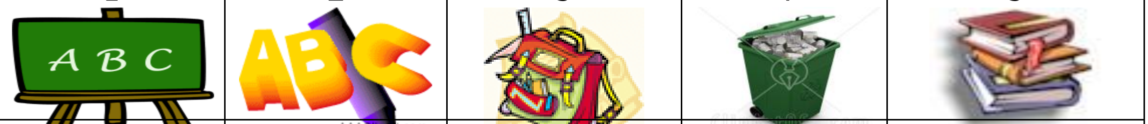
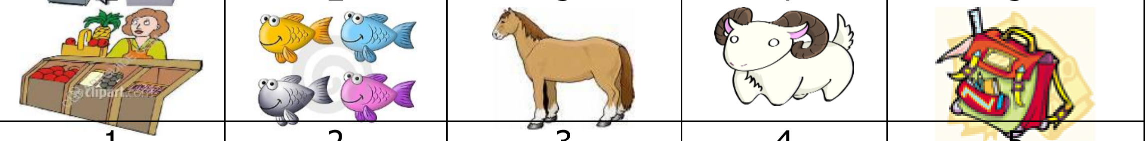
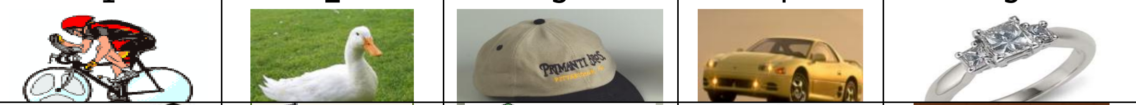
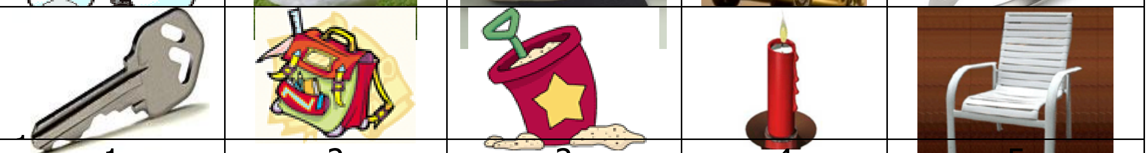
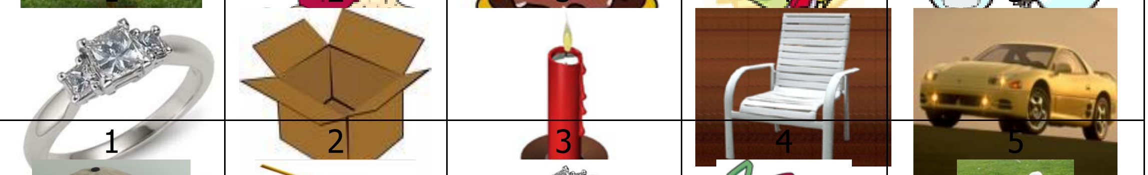
	Item	key	
a	ساعة	1	
b	شجرة	2	
c	يهاتف	2	
d	أذن	2	
1	يودع	3	
2	يقطر	1	
3	جزيرة	4	
4	غصن	3	
5	زاوية	2	
6	جارح	3	
7	يفرم	2	
8	خماسي	4	
9	مغارة	4	
10	يملأ	3	
11	منقوش	3	
12	يعتدي	1	
13	يتلصص	1	
14	متدفق	2	
15	يقذف	1	
16	يروي	1	
17	قمع	2	
18	موجع	2	
19	يتأرجح	2	
20	يتخطى	1	
21	سنبلة	1	
22	محقنة	1	
23	مندهش	3	
24	حلية	1	
25	إبريق	4	
26	فراء	4	
27	يصغي	1	
28	يرمم	3	
29	يتهالك	4	
30	يتبارى	1	
31	يسعف	1	
32	مجهر	3	
33	يرتطم	2	
34	ثوران	3	
35	يثقب	2	
36	وتري	2	
37	برمائي	2	
38	عواء	1	
39	يلوح	1	
40	سباك	2	
41	ينسكب	4	
42	أصل	4	
43	جبهة	1	

Key answers to the English Vocabulary (before piloting)

	Item	key	
a	pen	3	
b	cat	1	
c	walking	4	
1	bee	2	
2	banana	2	
3	brushing	3	
4	apple	5	
5	beach	1	
6	swimming	5	
7	fish	2	
8	sick	1	
9	books	5	
10	fruit	2	
11	horse	3	
12	car	4	
13	chair	5	
14	bathroom	4	
15	cake	3	
16	box	2	
17	duck	5	
18	bread	4	
19	sea	3	
20	cheese	4	
21	clock	3	
22	bus	2	
23	cooking	1	
24	family	3	
25	food	2	
26	tern	3	
27	loom	4	
28	cardamom	3	
29	hedgehog	3	
30	anthemis	5	
31	minaret	2	
32	pottery	5	
33	caravan	4	
34	hook	3	
35	gecko	4	

Initial English Vocabulary Test

a	1	2	3	4	5
b	1	2	3	4	5
c	1	2	3	4	5
1	1	2	3	4	5
2	1	2	3	4	5
3	1	2	3	4	5
4	1	2	3	4	5
5	1	2	3	4	5
6	1	2	3	4	5
7	1	2	3	4	5
8	1	2	3	4	5

9	1	2	3	4	5 
10	1	2	3	4	5 
11	1	2	3	4	5 
12	1	2	3	4	5 
13					
14	1	2	3	4	5 
15	1	2	3	4	5 
16	1	2	3	4	5 
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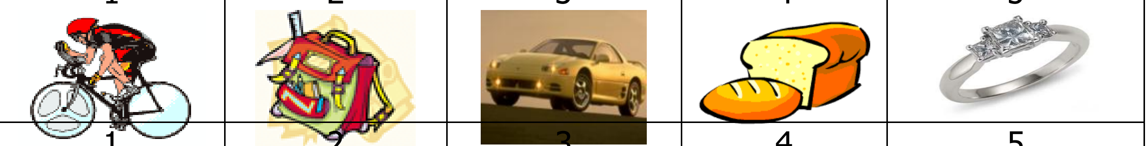
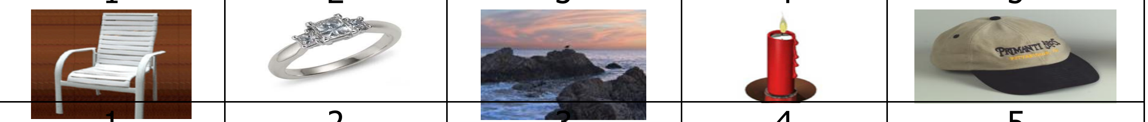
18	1	2	3	4	5 
19	1	2	3	4	5 
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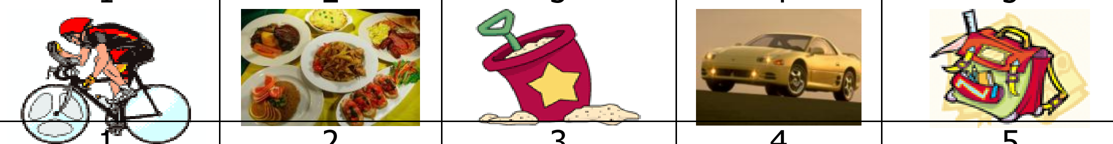
25	1 	2	3	4	5
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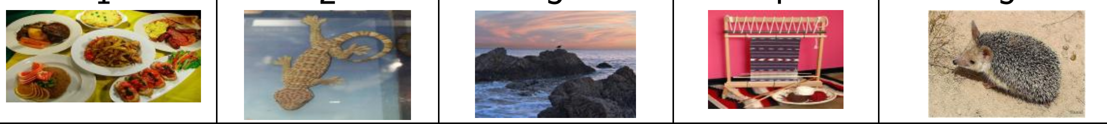
27	1 	2	3	4	5
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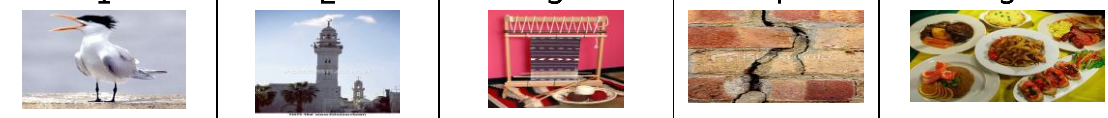
31	1 	2	3	4	5
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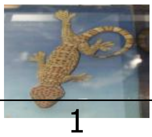
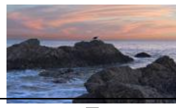
33	1 	2 	3 	4 	5 
34	1 	2 	3 	4 	5 
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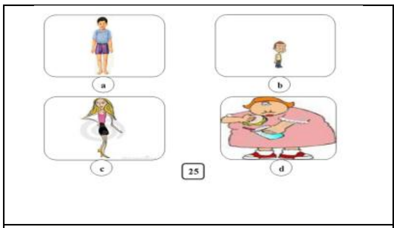
Key answers to Final English Vocabulary after piloting

	Item	key	
a	pen	C	
b	cat	A	
c	walking	B	
1	honey	D	
2	bread	B	
3	sea	A	
4	mosque	D	
5	eggs	D	
6	swim	C	
7	yellow	C	
8	hear	B	
9	dangerous	D	
10	jungle	B	
11	praying	B	
12	tall	A	
13	round	D	
14	slow	A	
15	cup	D	
16	afraid	C	
17	clean	D	
18	delicious	C	
19	write	A	
20	drink	A	
21	winter	D	
22	expensive	A	
23	many	C	
24	cut	D	
25	fat	D	
26	sunset	C	
27	tail	A	
28	sailing	B	
29	rainbow	C	
30	ambulance	B	
31	fireman	D	
32	bridge	C	
33	smoke	B	
34	pilot	B	
35	helmet	D	
36	fifth	C	
37	artist	D	
38	left	A	
39	diving	D	
40	winner	D	
41	island	A	
42	stomach	D	
43	hive	A	
44	snake	B	
45	lizard	C	

Final English Vocabulary Measure



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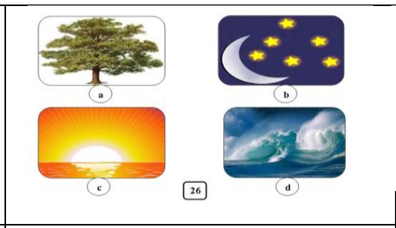

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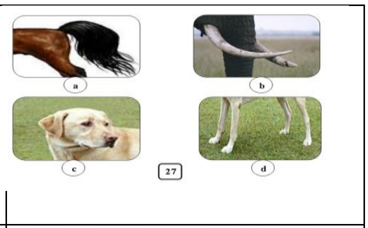

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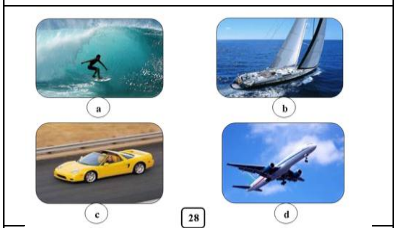

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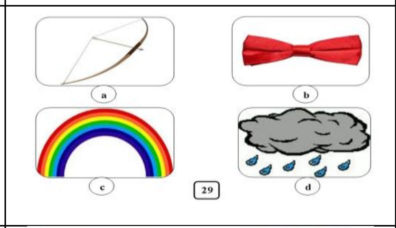

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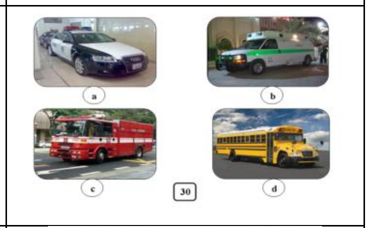

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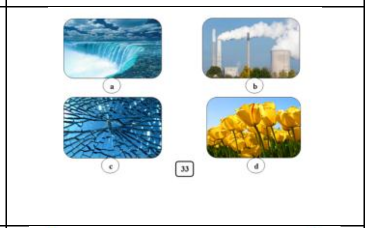

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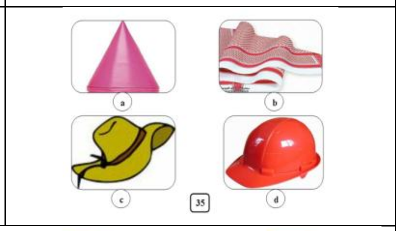

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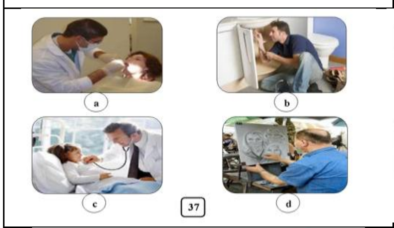

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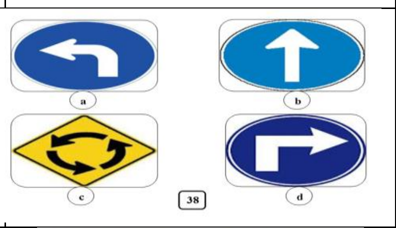

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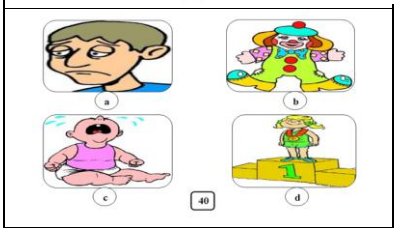

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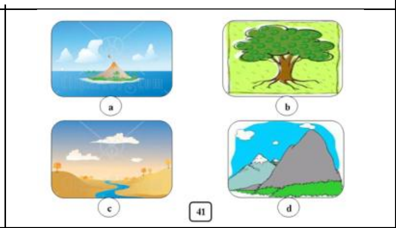

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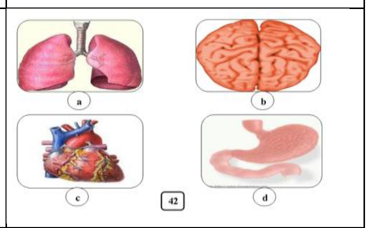

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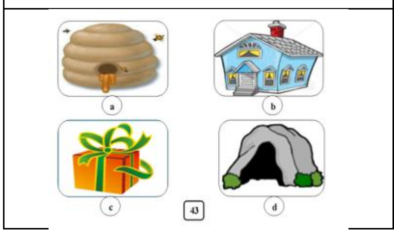

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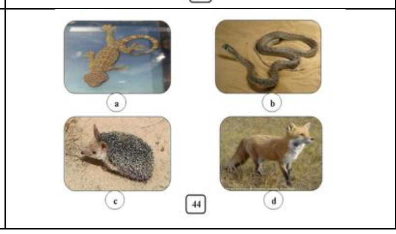

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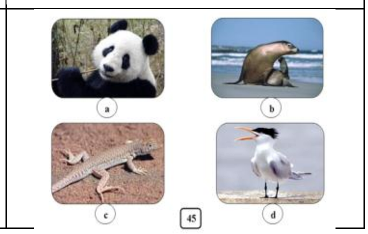

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Appendix 4: Phoneme Deletion Tasks

Initial English phoneme deletion task – before piloting

Examples:

1. Cat (K) at
2. Stop (p) sto
3. Simple (M) si/ple

No	word	sound	correct	
1	rice	n	ice	
2	nice	r	ice	
3	farm	f	arm	
4	girl	g	irl	
5	cat	k	ar	
6	paint	p	aint	
7	book	b	ook	
8	gold	g	old	
9	pencil	p	encil	
10	mouse	m	ouse	
11	cup	p	cu	
12	cold	d	col	
13	jump	p	jum	
14	bird	d	bir	
15	falcon	n	falco	
16	ram	m	ra	
17	flag	g	fla	
18	swim	m	swi	
19	boat	t	boa	
20	mouth	th	mou	
21	king	n	kig	
22	woman	m	wo/an	
23	frog	r	fog	
24	silk	l	sik	
25	begin	g	be/in	
26	basket	k	bas'et	
27	flag	l	fag	
28	brown	r	bown	
29	bands	d	bans	
30	monkey	k	money	
Total				

Final English phoneme deletion task - after piloting

Examples:

4. Cat (K) at
5. Stop (p) sto
6. Simple (M) si/ple

No	word	sound	correct	
1	rice	n	ice	
2	nice	r	ice	
3	farm	f	arm	
4	girl	g	irl	
5	car	k	ar	
6	paint	p	aint	
7	book	b	ook	
8	gold	g	old	
9	pencil	p	encil	
10	mouse	m	ouse	
11	cup	p	cu	
12	cold	d	col	
13	jump	p	jum	
14	bird	d	bir	
15	falcon	n	falco	
16	ram	m	ra	
17	flag	g	fla	
18	swim	m	swi	
19	boat	t	boa	
20	mouth	th	mou	
21	king	n	kig	
22	woman	m	wo/an	
23	frog	r	fog	
24	silk	l	sik	
25	brake	r	bake	
26	basket	k	bas'et	
27	flag	l	fag	
28	brown	r	bown	
29	bands	d	bans	
30	monkey	k	money	
Total				

Appendix 5: Rapid Naming Measures

Drill Model

Model A

Model B

Appendix 6: Non-word repetition tasks

English Non-word repetition test - before piloting

Drill: frosk – sheank – splan – frimp

Items: Jint – tam - Blim – Gruss –chove - skoosh – tropment - plention – prejend - Miction – fitosal - sabotack – mispRelture - rebably – Ambrahili - prebalture – catashin - mysluwoon – Polonelist - Delikeraties - sholuteka - zalotipik - kariphanik

Final English Non-Word Repetition Test (after piloting)

jint – tam – blim – gruss – skoosh – chove – prejend – miction – plention – tropment – sabotack – catashin – fitosal – rebably – musluwoon – prebalture – mispRelture – ambrahili – sholuteka – zalitipick – kariphanic – delikeraties - polonolist

Appendix 7: English Orthographic Discrimination Test

1	pen	pen			26	orange	orange	
2	take	make			27	dad	bad	
3	more	more			28	class	clasp	
4	hot	not			29	room	root	
5	mother	mother			30	fun	fan	
6	school	school			31	smart	smart	
7	pad	pat			32	bright	fright	
8	hit	hot			33	hand	hang	
9	pod	pop			34	mint	mist	
10	room	zoom			35	band	bend	
11	soul	seal			36	clack	clock	
12	spoil	spoil			37	cram	gram	
13	spin	spit			38	frisk	frisk	
14	mad	map			39	trick	track	
15	rate	late			40	cladding	cladding	
16	soft	sift			41	shack	shock	
17	holy	holy			42	clad	glad	
18	smell	small			43	boy	bop	
19	frat	frit			44	drug	drum	
20	ball	tall			45	smack	smack	
21	band	band			46	buss	buzz	
22	bold	cold			47	draft	craft	
23	mouse	mouse			48	brick	brisk	
24	team	tear			49	extremely	extremely	
25	mug	mud			50	chip	ship	

Appendix 8: Word chain tasks

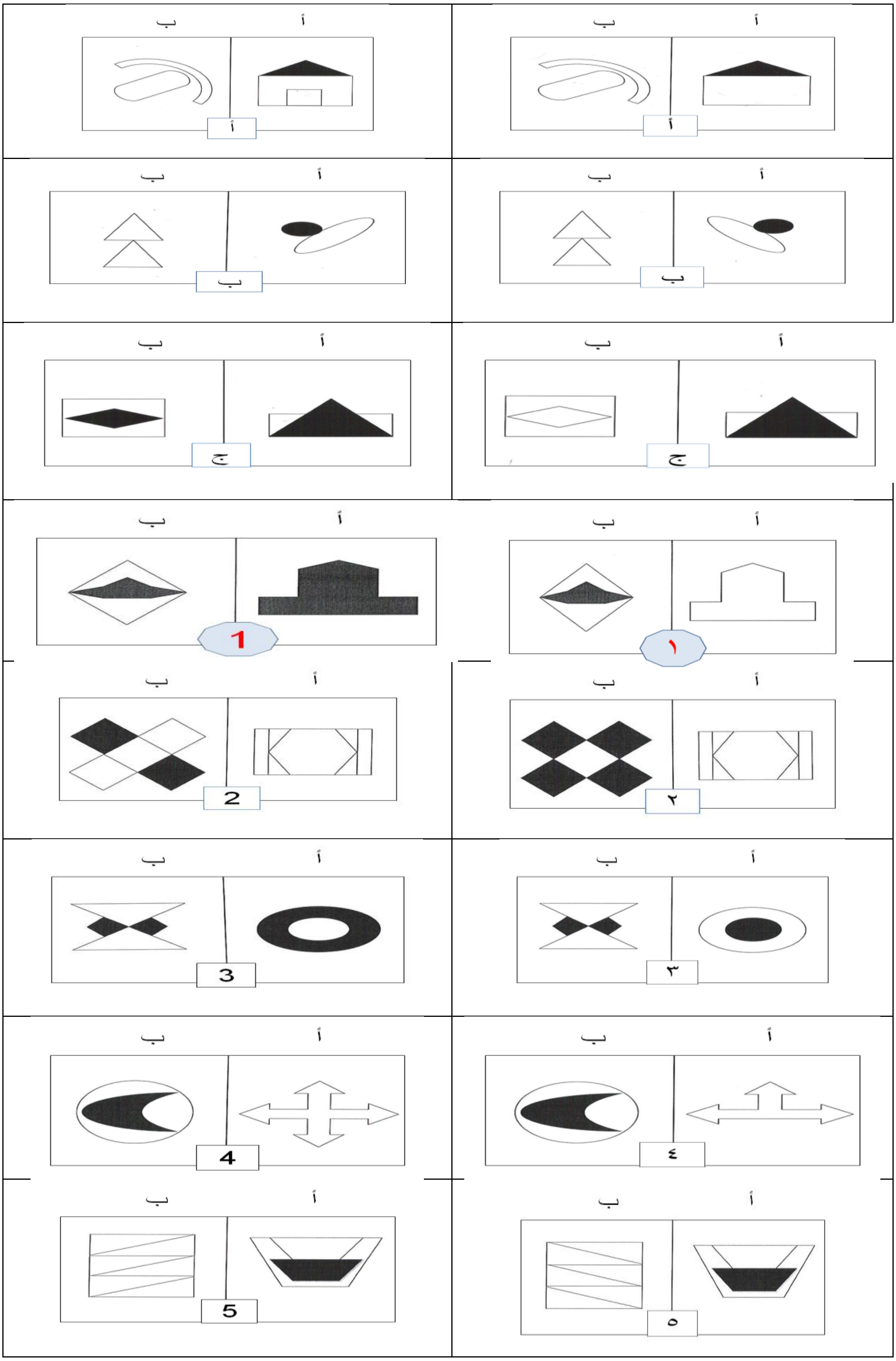
Initial English Word Chain– before piloting

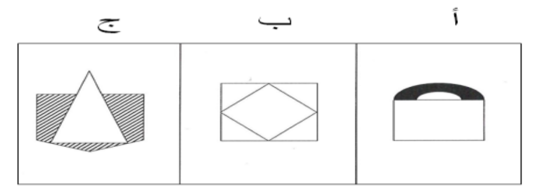
theboydidlioninmattwoschoolforwentbigpizzayeslongdaycatricefatherhowtoinhome

Final English Word Chain– after piloting

theboydidlioninmattwoschoolforwentbigpizzayeslongcatricehowtoinhome

Appendix 9: Visual Memory Test

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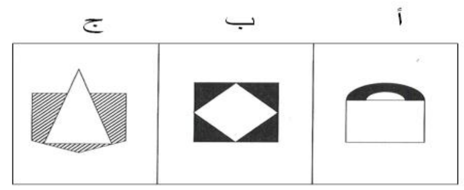
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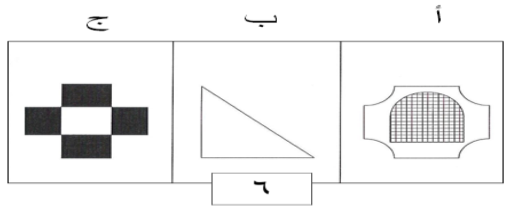
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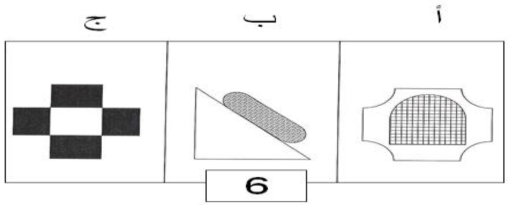
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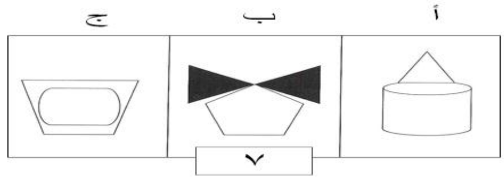
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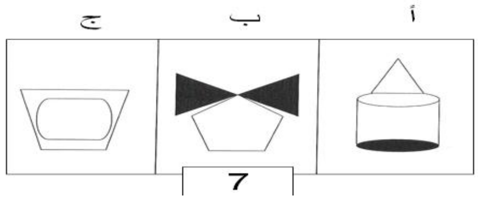
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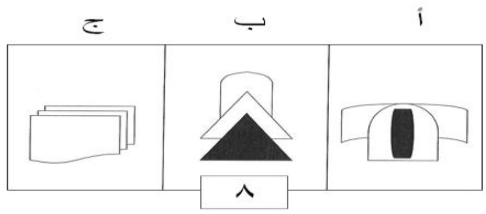
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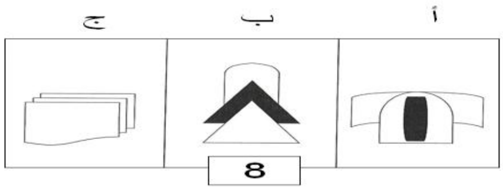
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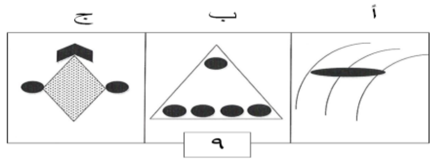
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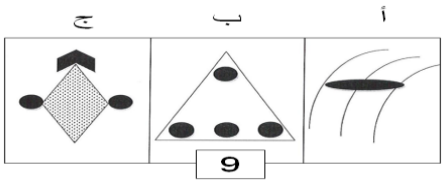
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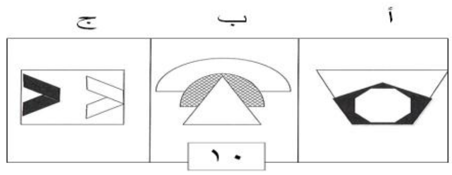
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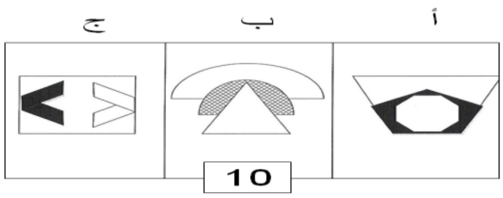
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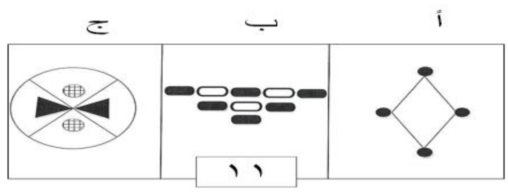
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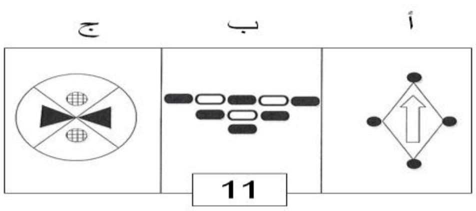
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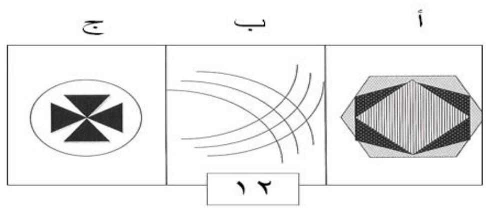
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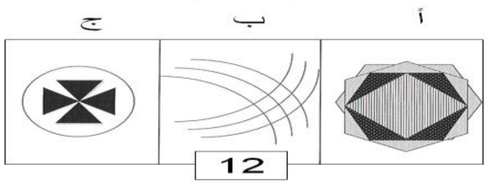
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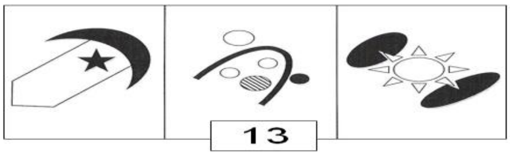

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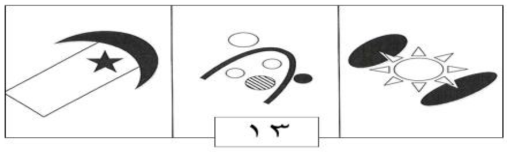

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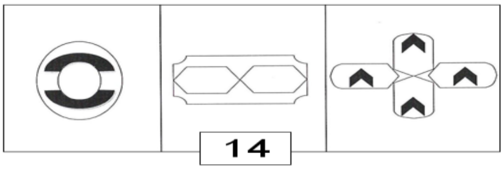

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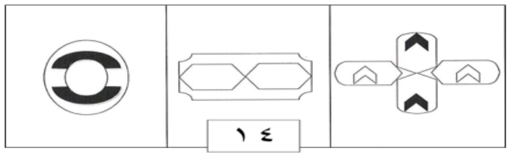

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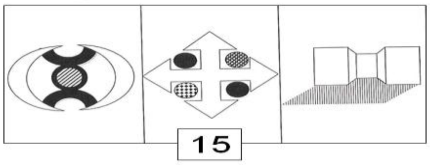

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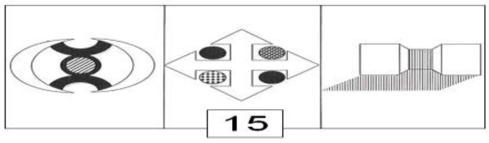

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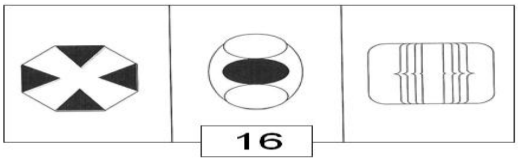

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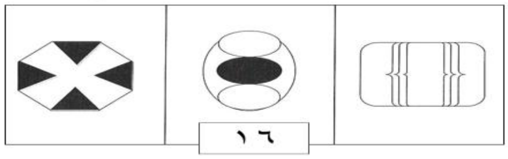

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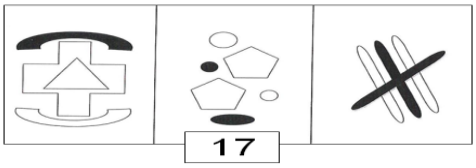

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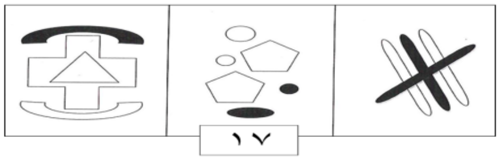

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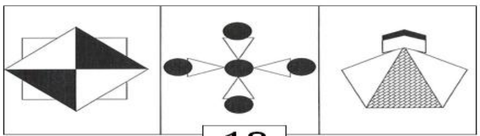

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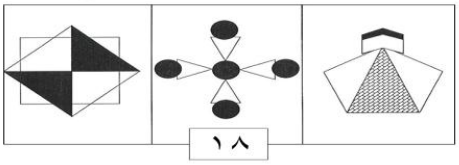

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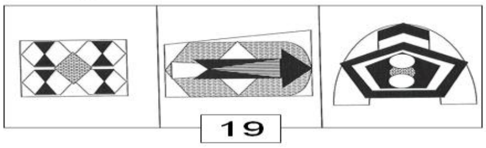

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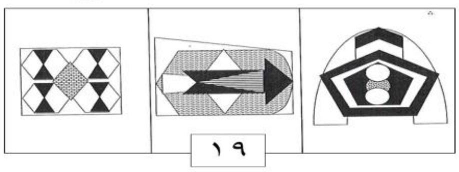

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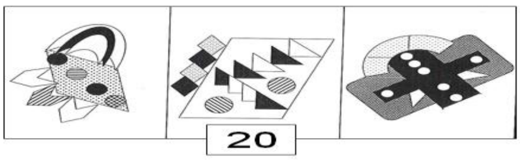

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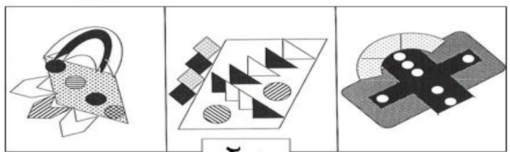

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Appendix 10: Syntactic Awareness Tasks

Final Arabic Syntactic Awareness

عصيرُ مفيدٌ البرتقالِ	ب	عصيرُ البرتقالِ مفيدٌ	أ	1
الجبلُ مرتفعٌ	ب	مرتفعٌ الجبلُ	أ	2
الحبوبَ الطائرُ أكلَ	ب	أكلَ الطائرُ الحبوبَ	أ	3
الكتابَ أحمدُ يقرأ	ب	يقرأُ أحمدُ الكتابَ	أ	4
يُعطِينَا البقرةُ الحليبَ	ب	تُعطِينَا البقرةُ الحليبَ	أ	5
خاشعاً أنسٌ صَلى	ب	صَلى أنسٌ خاشعاً	أ	6
في الكويتِ مستشفياتٌ كثيرةٌ	ب	في الكويتِ مستشفى كثيرةٌ	أ	7
إستعارتْ فاطمةُ كتاباً من المكتبةِ	ب	إستعارَ فاطمةُ كتاباً من المكتبةِ	أ	8
البحرِ مالحٌ طعمُ	ب	طعمُ البحرِ مالحٌ	أ	9
أنشأتْ حكومتُنا المدارسَ	ب	أنشأتْ حكومتَنا المدارسُ	أ	10
التلاميذُ المجتهدون محبوبون	ب	التلميذُ المجتهدون محبوبون	أ	11
الفلاحينَ متعاونونَ	ب	الفلاحونَ متعاونونَ	أ	12
يَتدلى التمرُ من النخلةِ	ب	يَتدلى التمرُ إلى النخلةِ	أ	13
ركبتُ السيارةَ من الجهراءِ إلى حولي	ب	ركبتُ السيارةَ من الجهراءِ في حولي	أ	14
النجمان مضيئان	ب	النجمين مضيئان	أ	15
أطعمَ المحسنُ مسكينين	ب	أطعمَ المحسنُ مسكينان	أ	16
تهتمُ الدولةَ بالتعليمُ	ب	تهتمُ الدولةُ بالتعليمِ	أ	17
يأكلُ الأرنبُ الجزرُ	ب	يأكلُ الأرنبُ الجزرَ	أ	18
تخرجُ الطالبةُ من الصفِ	ب	تخرجُ الطالبةُ من الصفُ	أ	19
أحمدُ من الفائزون	ب	أحمدُ من الفائزين	أ	20
الرائحة فاحتْ من الزهورِ	ب	الرائحة فاحتْ إلى الزهورِ	أ	21
رقبةُ الزرافةِ طويلةٌ	ب	رقبةُ الزرافةِ طويلتٌ	أ	22
شاهدَ محمدٌ خروفان	ب	شاهدَ محمدٌ خروفين	أ	23
شاركَ التلميذُ المعلمَ في الإعرابِ	ب	شاركَ التلميذُ المعلمَ في الإعرابُ	أ	24
كان النجمين ساطعين	ب	كان النجمان ساطعين	أ	25

Initial Syntactic Awareness English (before piloting)

1	A	a cake ate Ahmed.	B	Ahmed ate a cake.
2	A	The sun is big.	B	The sun does big.
3	A	The bear brown runs.	B	The brown bear runs.
4	A	They went at school.	B	They went to school.
5	A	He answered the phone.	B	He answered phone the.
6	A	I are happy.	B	I am happy.
7	A	The boy run quickly.	B	The boy ran quickly.
8	A	We thanked him very much.	B	We thanked him much very.
9	A	Sara drinking milk.	B	Sara is drinking milk.
10	A	The boy be sad.	B	The boy was sad.
11	A	The child the homework wrote.	B	The child wrote the homework.
12	A	The woman cooked fish.	B	The woman fish cooked .
13	A	The lion and the tiger eat meat.	B	The lion and the tiger eats meat.
14	A	I go to school on car.	B	I go to school by car.
15	A	The children play football.	B	The child play football.
16	A	The mother work very hard.	B	The mother works very hard.
17	A	Cats like fish.	B	Fish cat likes.
18	A	They went to London.	B	They went at London.
19	A	The boy ran after the dog.	B	The boy after ran the dog.
20	A	They watched a film.	B	They watched a films.
21	A	Boys wear trousers.	B	Boys wear trouser.
22	A	Did you go to the cinema?	B	Did you went to the cinema?
23	A	Are you happy?	B	Does you happy?
24	A	The tall man playing was basketball.	B	The tall man was playing basketball.
25	A	The school has far.	B	The school is far.
26	A	Pizza are delicious.	B	Pizza is delicious.
27	A	The children play in the garden.	B	The children in the garden play.
28	A	The red fish is pretty.	B	The pretty is red fish.
29	A	The new television is big.	B	The big television new is.
30	A	Ali went to Canada.	B	Ali went in Canada.
31	A	One of the children are sick.	B	One of the children is sick.
32	A	The child helps her parents.	B	The child help their parents.
33	A	My name is Mona.	B	Our name is Mona.
34	A	Can you fly?	B	Fly can you?
35	A	He isn't from Kuwait.	B	He couldn't from Kuwait.

Final English Syntactic Awareness Test

1	a	A cake ate Ahmed.	b	Ahmed ate a cake.
2	a	The sun is big.	b	The sun does big.
3	a	The bear brown runs.	b	The brown bear runs.
4	a	They went at school.	b	They went to school.
5	a	He answered the phone.	b	He answered phone the.
6	a	I are happy.	b	I am happy.
7	a	Sara drinking milk.	b	Sara is drinking milk.
8	a	The boy be sad.	b	The boy was sad.
9	a	The woman cooked fish.	b	The woman fish cooked.
10	a	Cats like fish.	b	Fish cat likes.
11	a	They went to London.	b	They went at London.
12	a	They watched a film.	b	They watched a films.
13	a	Boys wear trousers.	b	Boys wear trouser.
14	a	Are you happy?	b	Does you happy?
15	a	The tall man playing was basketball.	b	The tall man was playing basketball.
16	a	Pizza are delicious.	b	Pizza is delicious.
17	a	The children play in the garden.	b	The children in the garden play.
18	a	The red fish is pretty.	b	The pretty is red fish.
19	a	The new television is big.	b	The big television new is.
20	a	Ali went to Canada.	b	Ali went in Canada.
21	a	One of the children are sick.	b	One of the children is sick.
22	a	The child helps her parents.	b	The child help their parents.
23	a	My name is Mona.	b	Our name is Mona.
24	a	Can you fly?	b	Fly can you?
25	a	He isn't from Kuwait.	b	He isn't a Kuwait.

Appendix 11: Morphological Segmentation Task

Final Arabic Morphological Segmentation Task (items reordered)

ex: القلم =====> ال / قلم

بطة ======> بـ / طة

Items of the test:

طبيبة ـ الكتاب – العصفور – بحري – الباب – محاسبة – الفلاح – صناعي – يلعب – يشرب – صديقات – يذهب – يدان – تأكل – تنام – خياطة – شرقي – حارسان – عالمان – تمرح ـ معلمات ـ طالبات ـ لاعبون ـ عاملون ـ زارعون

Morphological Segmentation English – before piloting

ex. eating =====> eat/ing works ======> work/s

Items of the test

reading- running – beginner – babies – eats – heard – fattest – thinner – studied – wishes – artist – swimming – slower – cats – baker – careful – covered – useful – drinks – children – stranger – reorder – easiest – living - scientific

Final English Morphological Segmentation Task – (reordered)

Add / to divide each word into two parts then write the base word:

ex. eating =====> eat/ing

works ======> work/s

Items of the test:

cats – eats – reading – drinks – slower – covered – played – heard – wishes – thinner – useful – artist - babies - studied – living – children – beginner - - running – swimming – easiest – fattest – baker – careful – smaller - scientific

Appendix 12: Word reading tasks

Arabic Word Reading Test:

قالَ – الطعامْ - الَّذي- الشَّمسُ – عَنْ – نَفْسي – اِقْرَأْ – ذَلِكَ – اللَّيْلُ – الْعِبارات – عَدَدُ – النَّباتاتُ – بَعْضُ – الصّورَةُ – قِطْعَةُ – الْكَريمَةْ – الْحَيَّةُ – مَكِّيَّةْ – الْمُناسَبَةُ – أُلاحِظُ – خَبّابُ – الزّاوِيَةُ – اِسْتَخْرِجْ – شَفَهِيًّا – الْمِغْناطيسُ – اللِّيونَةْ – الْمُدَحْرَجاتْ – الْكَهْرُبائِيُّ – ثَلاثُمِائةْ - الآتِيَتَيْنِ

English Word Reading Test

go – zoo – pen – big – sun – fly – small – monkey – sing – today – rabbit – lion – cake – mat – bathroom – bakery – mosque – parrot – brown – bookshop – nuts – giraffe – does – under – because – cornflakes – calculator – supermarket – climb - circle

Appendix 13: Text Reading Measures

Arabic Reading Text 1

يُعَدُّ عُصْفورُ الذُّبابَةِ وَ مَوْطِنَهُ كوبا أَصْغَرَ طائِرٍ في الْعالَمِ، فَهوَ يَزِنُ جِراميْنِ فَقَطْ، وَ طولُهُ لا يَتَجاوَزُ سِتَّةَ سَنْتِمِتْراتٍ، وَ لِذَلِكَ سُمِّيَ عُصْفورَ الذُّبابَةِ.

Arabic Reading Text 2

كانَ جُحا يَسْكُنُ في بَيْتٍ ريفِيٍّ صَغيرٍ, تُحيطُ بِهِ الأشْجارُ المُثْمِرَةُ, وَ كانَ يَمْلِكُ حِماراً, فَأَرادَ جارُهُ أَنْ يَسْتَعيرَ مِنْهُ الْحِمارَ, لَكِنَّ جُحا اعْتَذَرَ إِلَيْهِ بِهُدوءٍ, وَ أَخْبَرَهُ أَنَّ الْحِمارَ ذَهَبَ بِهِ أَبْناؤُهُ إِلى الْحَقْلِ, وَ بَيْنَما هُما كَذَلِكَ إِذا بِالْحِمارِ يَنْهَقُ, فَقالَ الْجارُ: حِمارُكَ مَوْجودٌ سَمِعْتُ صَوْتَهُ, فَرَدَّ جُحا: عَجَباً أَتُصَدِقُ الْحِمارَ وَ لا تُصَدِّقُني؟

English Reading Text 1

My family and I go shopping every Friday. We buy food for the week. I like cakes and honey. My brother loves chocolate biscuits. My sister buys books and colours. My mother gets bread from the bakery. We put things in the basket and pay money.

Appendix 14: Word Spelling Tasks

English Word Spelling, Examiner's form

1	**to**	I go **to** school.	**to**
2	**the**	**The** book is new.	**the**
3	**so**	I feel **so** happy.	**so**
4	**car**	We have a **car.**	**car**
5	**do**	**Do** you like apples?	**do**
6	**can**	**Can** you fly?	**can**
7	**did**	**Did** you do your homework?	**did**
8	**not**	I am **not** a boy/girl.	**not**
9	**cat**	The **cat** eats fish.	**cat**
10	**jam**	**Jam** is sweet.	**jam**
11	**run**	I **run** fast.	**run**
12	**legs**	We have two **legs**.	**legs**
13	**then**	I wash **then** I pray.	**then**
14	**hen**	A **hen** gives us eggs.	**hen**
15	**nine**	I am **nine** years old.	**nine**
16	**what**	**What** is your name?	**what**
17	**read**	I can **read** English.	**read**
18	**father**	I love my **father**.	**father**
19	**rabbit**	The **rabbit** eats carrots.	**rabbit**
20	**small**	Ants are **small**.	**small**
21	**write**	I can **write** my name.	**write**
22	**Earth**	The **Earth** is round.	**Earth**
23	**pink**	The flower is **pink**.	**pink**
24	**cream**	I love **cream.**	**cream**
25	**honey**	Bees make **honey**.	**honey**

26	**money**	I need **money** to buy things.	**money**
27	**room**	I put my things in my **room** .	**room**
28	**paint**	I **paint** pictures.	**paint**
29	**space**	The moon is in the **space**.	**space**
30	**difficult**	The test is **difficult**.	**difficult**
31	**ears**	I hear with my **ears**.	**ears**
32	**family**	I live with my **family**.	**family**
33	**below**	The book is **below** the table.	**below**
34	**bus**	I go to school by **bus**.	**bus**
35	**open**	**Open** the door.	**open**
36	**water**	We drink **water**.	**water**
37	**Friday**	We go to the mosque on **Friday**.	**Friday**
38	**good-bye**	We say **goodbye** to the teacher.	**good-bye**

Student's form

a	en in inn
b	reng rinj ring
c	mother mozer mather
1	tuo – two - to
2	za – the - tha
3	so – sau - saw
4	car – kar - ker
5	du – do - doo
6	can – kan - kam
7	ded – did - bid
8	not – nat - nod
9	kat – kad - cat
10	gam – jam - djam
11	ran – ren - run

12	legz – legs - lags
13	than – then - thin
14	hen – han - hin
15	nayn – nine - nin
16	wat – wot - what
17	read – reed - rid
18	fathar – fazar - father
19	rabit – rabbit - rabet
20	smol – smaul - small
21	rite – rayt - write
22	Earth – Arth - Erth
23	bink – pink - pinc
24	creem – kreem – cream
25	haney – honee - honey
26	many – money - monee
27	room – rom - rum
28	pant – pent - paint
29	spas – space - sbace
30	difikalt – difcalt - difficult
31	ears – earz - eers
32	phamili – family - family
33	bilo – beloo - below
34	puss – bus - bas
35	open – oben - opin
36	woter – watar - water
37	Fraiday – Fryday - Friday
38	god-bay good-bye good-bey

Appendix 15: Text Spelling Tasks

English Text Spelling

I go to the zoo on Friday. Father takes us on his car. Mother makes some food and juice. We see many animals there. My sister likes rabbits and my brother loves giraffes. Last week the lion was sick but we enjoyed the new tiger. I had a jam sandwich then I played with a small ball. My friend painted a picture. It was a nice day.

Appendix 16: Comprehension Tasks

English Reading Comprehension

1- Ali said: " I love reading English books at home."

1- What does Ali love? a- eating b- reading c- playing d- swimming	2- Ali reads books at……. a- home b- club c- cinema d- school

2- On Friday I go to my grandmother. I go with my family. I play with my sister and brother. We eat cakes and drink tea. We watch TV after lunch.

3- We go to grandmother on……………….. a- Friday b- Saturday c- Sunday d- Monday	6- I go to grandmother with my……… a- family b- friends c- teachers d- grandmother
4- I……………………with my sister. a- dance b- run c- play d- read	7- What do you do after lunch? a- I swim b- I play games c- I watch TV d- I drink tea
5- We eat…………………. a- tea b- fruit c- cakes d- honey	

3- Ahmed goes to school every day. He is in grade three. He takes his books and pencils. He puts them in the bag. At school, he studies English and Arabic. Mrs. Sara teaches him science. His favourite class is music. He can play the piano with is friend Sami.

8- Ahmed goes to school every………………. a- week b- day c- month d- year	11- Who teaches Ahmed science at school? a- Mrs Eman b- Mrs Sara c- Mr Ahmed d- Sami
9- What does he put in his bag? a-His clothes b- His pencils only c- His books only d- His books and pencils	12- What is his favourite subject? a- Music b- Science c- English d- Arabic
10- How many subjects did you read about? a- Two b- Four c- One d- Ten	13- Who does Ahmed play with? a- His father b- His teacher c- His brother d- His friend

4- My name is Mona. Last Saturday I went to the zoo with my family. I saw the monkeys and the giraffe. My sister, Huda, loved the birds very much. They were singing and flying. We also saw the lion and the tiger. They eat meat, but the zebra and the elephant eat grass.

14- Who is Mona's sister? a- Mona b- Sara c- Reem d- Huda	17- What does the zebra eat? a- It eats grass b- It eats chicken c- It eats pizza d- It eats meat
15-What did Mona see at the zoo? a- Animals only b- Animals and birds c- Books d- birds only	18-Which animals eat meat? a- The giraffe and the tiger b- The lion and the elephant c- The elephant and the zebra d- The tiger and lion
16- Why did Sara love the birds? a- Because they are small b-Because she eats them c- Because they fly and sing d- Because they are big	19- When did Mona go to the zoo? a- Last year b - At the weekend c- On a school day d- On Friday

5- In the past Kuwait was very simple. The men went fishing in a dhow. The women got water from the well. They used tools at home and work. Children didn't go to school. They studied in the mosque or at home. They studied reading and writing. They study Maths, too. They had no cars. They had camels and horses. They had falcons too. The houses were small.

20- Where did people get water from in the past? a- From the sea b- From wells c- From the shop d- From London	24- How were the houses like? a- They were small b- They were yellow c- They were big d- They were modern
21- What did people use at home? a- dhow b- tents c- nets d- tools	25- What was the work of men in the past? a- nurses b- doctors c- fishermen d- policemen
22- What did the children study? a-Writing only b- Reading only c- Maths only d- All of them	26-How did people travel in the past? a- By cars b- By planes c - By animals d- By taxi
23- Where did the children study? a- At schools b- On the beach c- At the zoo d- In the mosque	27- How was life in the past different from now? a- It was simple b- It was noisy c- It was fast d- It was crazy

English Comprehension Fluency

1- I go to school by…………………….

a- plane
b- ship
c- car
d- camel

2- We see the………… in the sky.

a-tree
b-sun
c-fish
d-dog

3- I eat breakfast in the……………….

a- morning
b- evening
c- afternoon
d- night

4- We can see the …………………..at the zoo.

a- ship
b- lion
c- sea
d- jungle

5- There are …………………days in the week.

a- nine
b- five
c- ten
d- seven

6- I can see with my ……………………….

a- eyes
b- ears
c- legs
d- foot

7- We read……………………..at school.

a- pictures
b- books
c- pens
d- films

8- We know the time by ………….

a- pen
b- picture
c- clock
d- book

9- The chicken eats ……..

a- banana
b- meat
c- seeds
d- book

10- The ……………..lives in water .

a- elephant
b- bird
c- giraffe
d- fish

11- Cheese is made of ……………….

a- honey
b- eggs
c- bread
d- milk

12- The children play in the ……………………………

a- cage
b- garden
c-hospital
d- plane

13- The ……………..is a big animal .

a-elephant
b- mouse
c-chicken
d- rabbit

14- We get honey from …………..

a- ants
b- bees
c- spiders
d- cats

15- We use the …………to travel by sea .

a- train
b- ship
c- car
d-bicycle

16- A…………... is an animal with a long neck .

a- mouse
b- fox
c- giraffe
d- sheep

17- We can hear with our………………………

a- nose
b- eyes
c- ears
d- hands

18- We buy bread from the………………………….

a- cinema
b- club
c- bakery
d- school

19- A hand is a part of the ………..

a- body
b- street
c- team
d- party

20- A ………… is a bird which eats meat .

a- cat
b- chicken
c- falcon
d- parrot

21- The weather is very hot in ………..

a- winter
b- spring
c- summer
d- autumn

22- A mother ……….. her children .

a- kills
b- loves
c- eats
d- drinks

23- We pray in the…………………

a- bank
b- mosque
c- bathroom
d- kitchen

24- We go to the……………….when we are sick.

a- farmer
b- policeman
c- doctor
d- fireman

25- We…………………………in Ramadan.

a- fast
b- dance
c- run
d- sit

26- My mother cooks……………………

a- books
b- food
c- water
d- juice

27- Apples are…………………………

a- purple
b- red
c- black
d- blue

28- The …………………… lives in the jungle.

a- tiger
b- cat
c- dog
d- sheep

29- The………………….. is very fast.

a- bus
b- turtle
c- plane
d- bear

30- I put my books in the……………………….

a- glass
b- bag
c- cup
d- pen

31- I help my mother to……………. the house.

a- drink
b- write
c- eat
d- clean

32- ………………….. are delicious.

a- cakes
b- ants
c- tables
d- chairs

33- I ………………… in the pool.

a- run
b- swim
c- sleep
d- travel

34- We get milk from the……………………….

a- fox
b- fish
c- cow
d- wolf

35- We buy medicine from the………………………..

a- bank
b- zoo
c- bakery
d- pharmacy

36 – We have two……………………………

a- hairs
b- hands
c- fingers
d- noses

37- The driver has a …………………………….

a- fire
b- car
c- farm
d-supermarket

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38 – There is a lot ………………… in the desert.

a- water
b- oil
c- sand
d- rain

39- A tree is a …………………………..

a- fish
b- animal
c- plant
d- bird

40- We keep money in the ………………………….

a- tower
b- school
c- bank
d- hospital

41- Kuwait is a small………………………….

a- farm
b- city
d- village
e- country

42- A …………………… has no legs.

a- fox
b- snake
c- bird
d- child

43- We need a ball for……………………..

a- tennis
b- swimming
c- running
d- walking

44- The ……………………… plays music

a- basket
b- piano
c- circle
d- bed

45- We know time by………………………………..

a- pen
b- picture
c- clock
d- book

46- The …………………..fights for our country.

a- gun
b- pen
c- soldier
d- teacher

47- The……………………lays eggs.

a- palm
b- rooster
c- elephant
d- chicken

48- The carpenter makes chairs from……………………

a- glass
b- paper
c- thread
d- wood

49- The ………………builds a nest in a tree.

a- elephant
b- giraffe
c- bird
d- lion

50- A…………………is an animal with two wings.

a- bat
b- goat
c- snake
d-lizard

Appendix 17: Composition Tasks

English Composition Task:

Write a short paragraph of **five** sentences to describe this picture:

Arabic Composition Task: